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1748 West Truck Road
Otis ANGB, MA 02542

30 March 2012

Mr. Jonathan S. Davis
Remediation Program Manager
HQ AFCEE/MMR
322 E. Inner Road
Otis ANG Base, MA 02542-5028

**SUBJECT: AFCEE 4P08 FA8903-08-D-8769; Task Order 0300
MMR SPEIM/LTM/O&M Program
CDRL #A001j
Fuel Spill-1 2011 Summary Letter Report**

Dear Mr. Davis:

The purpose of this Summary Letter Report (SLR) is to document the results of sampling activities conducted at the Fuel Spill-1 (FS-1) plume under the System Performance and Ecological Impact Monitoring (SPEIM) program during the 2011 calendar year. This deliverable contains no detailed assessment or evaluation of the results, but is a means of documenting all the actions completed under the FS-1 SPEIM program. The data collected under the SPEIM program are continually assessed and the results of these assessments are presented initially during the Technical Update Meetings and then through Technical Memoranda or Project Note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

This letter report includes a summary of the activities performed and the data collected for the FS-1 SPEIM program between 01 January 2011 and 31 December 2011. The FS-1 plume is defined as the extent of groundwater contaminated with ethylene dibromide (EDB), the FS-1 plume contaminant of concern (COC), at concentrations exceeding the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter ($\mu\text{g}/\text{L}$). Lead, thallium, and toluene are COCs for the FS-1 source area groundwater (AFCEE 2000). Lead continues to be monitored through biennial sampling of source area monitoring wells. However, the source area groundwater is no longer monitored for toluene and thallium because toluene has not been detected at concentrations above the Maximum Contaminant Level of 1,000 $\mu\text{g}/\text{L}$ since 1999 and thallium was not detected at source area groundwater monitoring wells during 12 sampling events completed between 2002 and 2005 (AFCEE 2005).

The Air Force Center for Engineering and the Environment (AFCEE) installed the FS-1 extraction, treatment, and discharge (ETD) system as a pilot test, which operated between 05 April 1999 and 13 October 2002, when a fire destroyed the treatment plant. The pilot ETD system was located in the southern portion of the plume and consisted of one extraction well (36EW0005) and 175 shallow wellpoints (SWPs) that operated at a combined extraction rate of 750 gallons per minute (gpm). The final remedy for the FS-1 plume was identified in the Final Record of Decision as continued operation of an ETD

system (AFCEE 2000). Based on plume characterization and groundwater modeling completed subsequent to issuance of the ROD, the final ETD system was designed as described in the final wellfield design report (AFCEE 2001). A Final Explanation of Significant Differences was submitted in September 2011 that clarified the inclusion of monitored natural attenuation as a component of the selected remedy, slightly modified the phrasing of the remedial action objectives, added the well verification process associated with the Land Use Control (LUC) program, and updated the steps to achieve site closure (i.e., the three step process) (AFCEE 2011a).

The final ETD system began operating on 30 September 2003 (AFCEE 2005). It was designed to extract and treat groundwater at a rate up to 750 gpm using four extraction wells (36EW0001, 36EW0005, 36EW0007, and 36EW0011) located in the south-central portion of the plume. The FS-1 plume and treatment system are presented in [Figure 1](#). The southernmost extraction well (36EW0001) replaced the SWP system, which was decommissioned in November 2003 (AFCEE 2005). The extracted groundwater is conveyed to the treatment plant where it is treated by a granular activated carbon system and discharged to the K1 and K2 bog ditches via three vertical riser pipes (i.e., bubblers). The FS-1 ETD system was optimized in 2007, which entailed turning off 36EW0007 and adjusting flows at the remaining three extraction wells, and resulted in a new total extraction rate of 515 gpm (2007 Scenario 01) (AFCEE 2007a). During 2011, the FS-1 ETD system continued to operate under pumping configuration 2007 Scenario 01.

FS-1 SPEIM ACTIVITIES

The SPEIM program was developed to monitor plume changes and to ensure the effective operation of AFCEE groundwater remediation systems at the Massachusetts Military Reservation (MMR). These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. Activities completed for the FS-1 SPEIM program during 2011 include the following:

SPEIM Sampling Activities:

- Annual groundwater sampling for EDB analysis (June 2011).
- Biennial groundwater sampling for lead analysis (June 2011).
- Surface water sampling at the Quashnet River bog complex (August 2011).
- Semiannual extraction well sampling (June 2011 and December 2011).
- Monthly treatment plant sampling (January 2011 through December 2011).
- Recording of daily average treatment system flow rates (January 2011 through December 2011).
- Post-packer installation influent sampling at 36EW0001 (July 2011 through December 2011).

The groundwater and surface water locations sampled for the FS-1 SPEIM program in 2011 are presented in [Figure 2](#). The well construction and surface water sample location information is included in [Table 1](#). The current approved FS-1 SPEIM network, including

analytical scope and methods, is presented in the *Comprehensive Long Term Monitoring Plan*, which is available from AFCEE.

Groundwater and surface water analytical results are presented in [Table 2](#). A map showing the distribution of EDB detections in groundwater is included as [Figure 3](#). A comparison of compounds detected in groundwater, surface water, and treatment plant samples to applicable standards is included in [Attachment A](#).

Drilling and Direct-Push Activities:

No drilling or direct-push activities were completed at FS-1 in 2011.

Data Summary Report:

The data summary report for the analytical data reported in this SLR is included in [Attachment B](#).

Presentations:

Presentations for the FS-1 plume are listed in [Table 3](#).

Project Note Submittals:

The project notes related to activities conducted for the FS-1 plume under the SPEIM program in 2011 are included in [Attachment C](#).

Report Submittals:

- *Fuel Spill-1 2010 Summary Letter Report* (March 2011) (AFCEE 2011b).

Major Events and Optimizations:

The FS-1 plume boundary was revised in March 2011 based on a review of groundwater and surface water data collected through December 2010. The plume boundary update was presented during the annual SPEIM data presentation at the 16 March 2011 Technical Update Meeting ([Table 3](#)) and documented in the *FS-1 2010 Annual SPEIM Data Presentation (October 2009-December 2010) and ETD System Optimization* project note ([Attachment C](#)).

Data collected under the SPEIM program indicated that the extent and magnitude of EDB concentrations in the FS-1 plume near 36EW0001 had declined significantly ([Table 2](#), [Figure 3](#)). Therefore it was concluded that this extraction well was no longer contributing to the remediation of the plume ([Table 7](#)). However, because 36EW0001 extracted a large volume of groundwater over a 60-foot long screen and detectable concentrations of EDB were reported at this well between December 2009 and December 2010 (0.017 µg/L – 0.011 µg/L), it was possible that EDB remained at concentrations at or greater than the MMCL of 0.02 µg/L near 36EW0001. Therefore, in July 2011 the effective screen length for this extraction well was shortened in an effort to focus extraction stresses to the portion of the aquifer where EDB plume may potentially remain. As of December 2011 flow testing associated with the optimization evaluation of 36EW0001 continued. The results of this evaluation and any recommended optimizations will be summarized in a project note scheduled for delivery in 2012.

FS-1 REMEDIAL STATUS UPDATE

Analytical results from the FS-1 treatment plant sampling are presented in [Table 4](#). Average weekly flow rates for the FS-1 extraction wells are presented in [Table 5](#). Treatment system operational downtimes or deviations (for events lasting two hours or longer) for 2011 are summarized in [Table 6](#). Mass removal calculations through December 2011 for the FS-1 treatment system are presented in [Table 7](#).

The most recent plume shell for the FS-1 plume included data collected through June 2006 (AFCEE 2007b). The 2006 FS-1 plume shell is estimated to contain approximately 459 million gallons of groundwater contaminated with EDB at concentrations above the MMCL; and approximately 1.15 pounds (lbs) of dissolved-phase EDB at concentrations above the MMCL.

The FS-1 ETD system removed approximately 0.11 lbs of EDB between January 2011 and December 2011. During this period, approximately 256 million gallons of groundwater were treated at the FS-1 treatment plant. Since system startup in April 1999, the system has removed approximately 17.87 lbs of EDB through the treatment of approximately 3.8 billion gallons of groundwater.

The operation of the FS-1 remedial system used approximately 274 megawatt hours of electricity during 2011. Power plant air emissions associated with this power generation for 2011 and since system startup in April 1999 are presented in [Table 8](#). Green energy purchases and power production from AFCEE's wind turbines are incorporated into these air emissions data.

The FS-1 ETD system operated with the 2007 Scenario 01 flow rates throughout most of 2011 ([Table 5](#)). Using the 2006 EDB plume shell and assuming that the system will operate continuously at the 2007 Scenario 01 flow rates, groundwater modeling results predict that the ETD system will continue to capture EDB until approximately 2020. After that time a small pod of low concentration EDB plume is predicted to remain in a basal silt at FS-1 through the last simulation time-step of 2031 (AFCEE 2007a). Through the SPEIM program, the Conceptual Site Model is routinely updated and the remedial system operation is continuously evaluated and optimized to reduce cleanup times, therefore the timeframes presented in this section will most likely be decreased in future scenarios.

FS-1 SPEIM ACTIVITIES PLANNED FOR 2012

Activities currently planned for the FS-1 SPEIM program for 2012 include the following:

- Annual and biennial groundwater sampling for EDB (June 2012).
- FS-1 annual/biennial SPEIM data presentation (Summer 2012).
- Semiannual sampling of operating extraction wells (June 2012 and December 2012).
- Annual surface water sampling (August 2012).
- Monthly treatment plant sampling (January 2012 through December 2012).
- Recording of daily average treatment system flow rates (January 2012 through December 2012).

- Synoptic water level measurements (as needed).
- Optimization of the FS-1 ETD system and chemical monitoring network.
- LUC Program private well verification surveys and sampling (as needed).

If you have any questions or comments, please contact Rose Forbes at (508) 968-4670, extension 5613.

Sincerely,

CH2M HILL



Patricia de Groot, P.G.
Program Manager

Attachments:

- | | |
|-------------------------------------|---|
| <u>Figure 1</u> | FS-1 Groundwater Plume and Treatment System |
| <u>Figure 2</u> | FS-1 Chemical Monitoring Network |
| <u>Figure 3</u> | FS-1 2011 Ethylene Dibromide Detections in Groundwater |
| <u>Table 1</u> | FS-1 Well Construction and Surface Water Sampling Location Information |
| <u>Table 2</u> | FS-1 Groundwater and Surface Water Monitoring Results |
| <u>Table 3</u> | FS-1 Meeting Presentations |
| <u>Table 4</u> | FS-1 Treatment Plant Sampling Results |
| <u>Table 5</u> | FS-1 Treatment System Flow Rates |
| <u>Table 6</u> | FS-1 Treatment System Downtime Summary |
| <u>Table 7</u> | FS-1 Treatment System Mass Removal Summary |
| <u>Table 8</u> | FS-1 Remedial System Electrical Consumption and Associated Air Emissions |
| <u>Attachment A</u> | Comparison of Detected Concentrations in FS-1 Groundwater, Surface Water, and Treatment Plant Samples to Applicable Groundwater and Surface Water Standards |
| <u>Attachment B</u> | FS-1 2011 SLR Data Summary Report |
| <u>Attachment C</u> | FS-1 Project Notes |

* c: Rose Forbes, AFCEE/MMR
Bob Lim, EPA
Leonard Pinaud, MassDEP
Denis LeBlanc, USGS
Glen Harrington, Mashpee BOH
Steve Hurley, MDFW

Martha Steele, DPH
Drew McManus, Mashpee Consrv.
Phil Brady, MA Div. of Marine Fisheries
Bill Fisher, Haley & Aldrich
CH2M HILL Doc. Control & Distribution

* Delivery via email.

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FIGURES

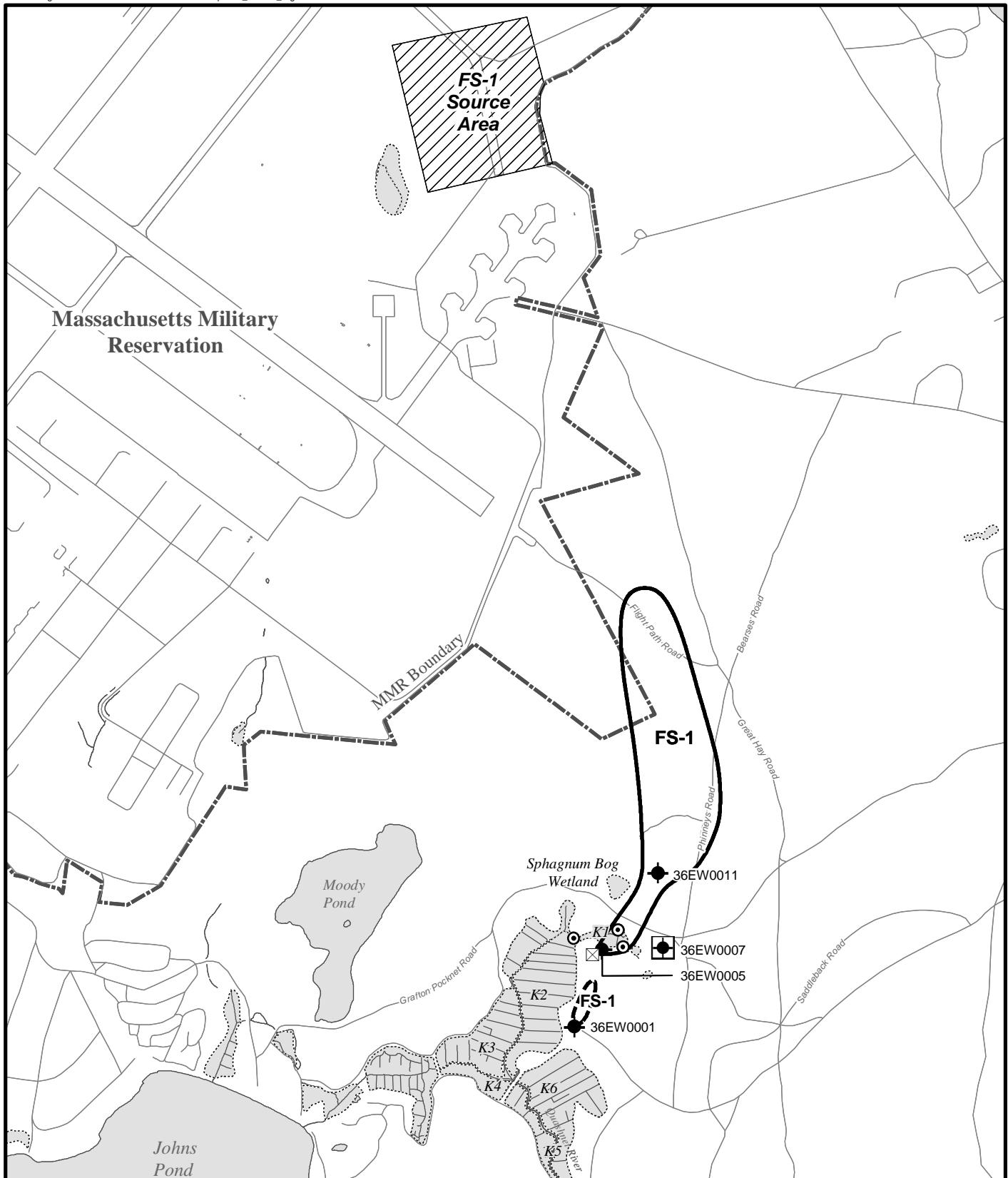
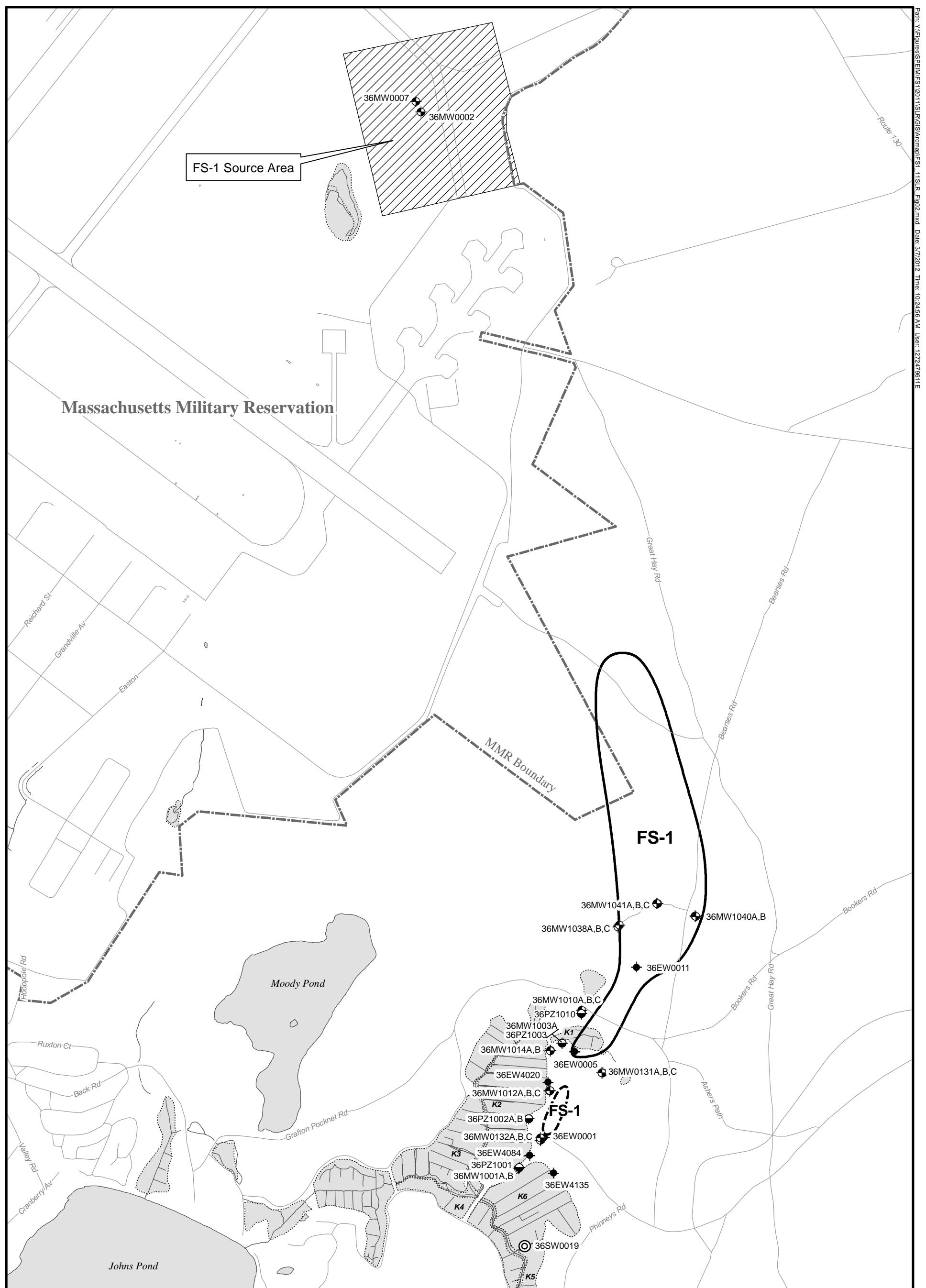


FIGURE 1

FS-1 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEE - Massachusetts Military Reservation
FS-1 2011 Summary Letter Report

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Legend

- | | | | |
|--|------------------------------------|--|--|
| | Monitoring Well | | Source Area |
| | Extraction Well | | Bog/Wetland |
| | Piezometer | | Plume Boundary
(Dashed Where Inferred) |
| | Surface Water
Sampling Location | | Massachusetts Military
Reservation Boundary |

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011



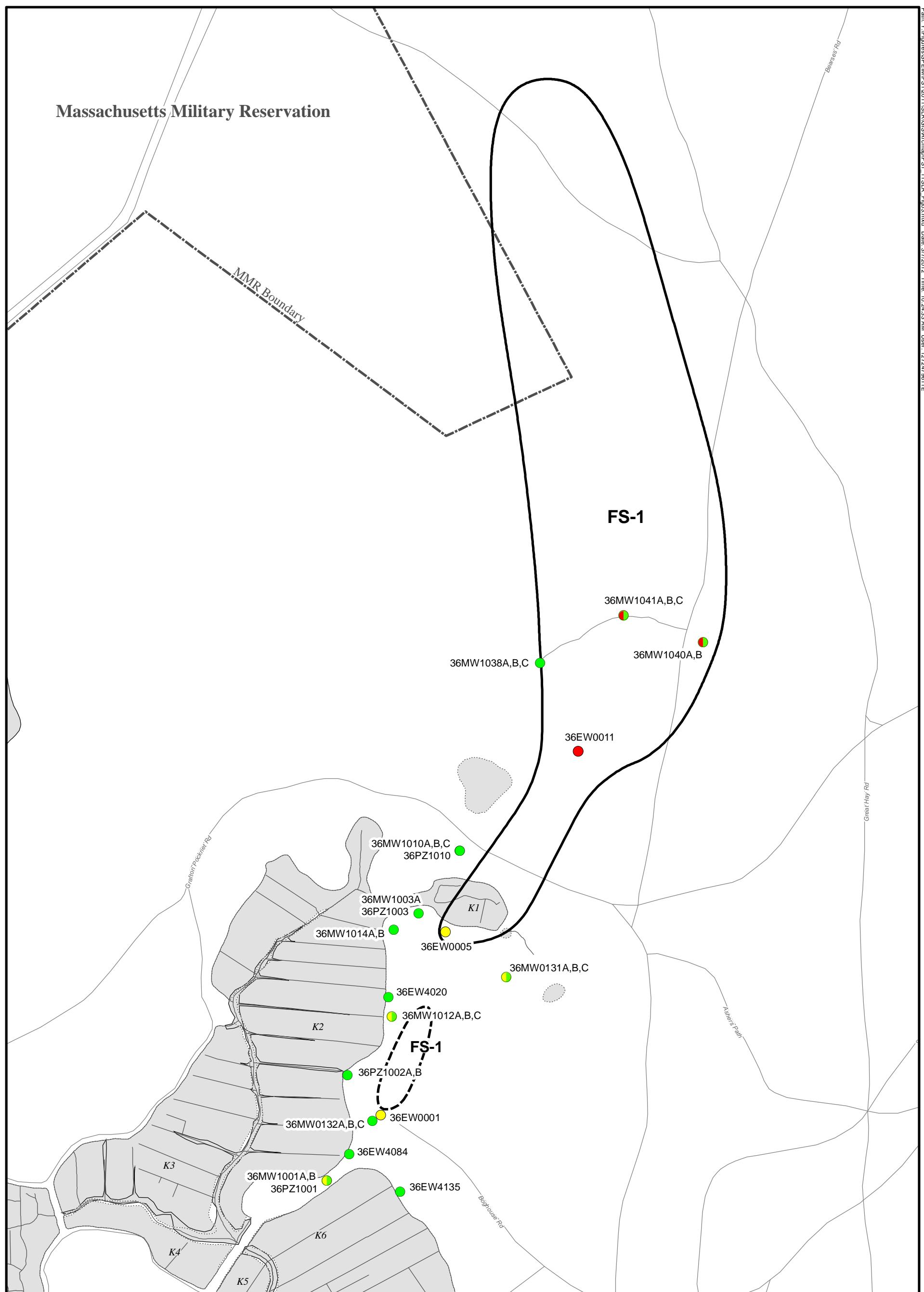
A scale bar with three tick marks. The first tick is at 0 feet. The second tick is at 350 feet. The third tick is at 700 feet. The distance between the 0 and 350 marks is the same as between the 350 and 700 marks.

FIGURE 2

FS-1 CHEMICAL MONITORING NETWORK

AFCEE - Massachusetts Military Reservation
FS-1 2011 Summary Letter Report

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Legend

— Plume Boundary
(Dashed Where Inferred)
- - - Massachusetts Military
Reservation Boundary
□ Bog/Wetland

Contaminant Detections:

- No Detection
- Detection Below or at MMCL
- Detection Above MMCL

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse
MMR Boundary from Massachusetts Air National Guard 2011



A scale bar representing 170 feet. It consists of a horizontal line with tick marks at 0, 170, and 340. The segment between 0 and 170 is filled with a dark gray color, while the segments beyond 170 and the entire bar are white. The word 'Feet' is written in a black sans-serif font to the right of the scale bar.

FIGURE 3

FS-1 2011 ETHYLENE DIBROMIDE DETECTIONS IN GROUNDWATER

AFCEE - Massachusetts Military Reservation FS-1 2011 Summary Letter Report

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TABLES

Table 1
FS-1 Well Construction and Surface Water Sampling Location Information
FS-1 2011 Summary Letter Report

Location	Northing (ft)	Easting (ft)	Surface Elevation (ft msl)	Measuring Point Elevation (ft msl)	Total Well Depth (ft bgs)	Top Screen Elevation (ft msl)	Bottom Screen Elevation (ft msl)	Screen Length (ft)
36EW0001 ^(1, 6)	233941	871784	56.44	50.46	191	-5.22	-129.37	124
36EW0005 ⁽²⁾	234603	872017	39.91	38.40	191	-84.39	-146.09	10
36EW0011 ⁽³⁾	235254	872496	93.53	87.43	249	-88.64	-150.63	62
36EW4020 ⁽⁴⁾	234368	871812	36.19	36.44	21	19.19	16.19	3
36EW4084 ⁽⁴⁾	233801	871670	35.14	35.39	21	17.64	14.64	3
36EW4135 ⁽⁴⁾	233665	871854	34.38	34.63	20	17.38	14.38	3
36MW0002	241852	870832	105.75	108.75	56	59.29	49.29	10
36MW0007	241934	870793	107.2	110.14	56	61.2	51.2	10
36MW0131A	234440	872236	52.15	54.39	186	-127.85	-132.85	5
36MW0131B	234440	872228	53.37	55.25	139	-80.63	-85.63	5
36MW0131C	234439	872228	53.37	55.3	90	-31.63	-36.63	5
36MW0132A	233922	871754	54.3	53.96	190	-130.7	-135.7	5
36MW0132B	233922	871754	54.3	53.96	140	-80.7	-85.7	5
36MW0132C	233936	871754	54.61	53.98	83	-23.39	-28.39	5
36MW1001A	233707	871589	34.48	33.36	150	-110.52	-115.52	5
36MW1001B	233701	871582	34.63	34.13	100	-60.37	-65.37	5
36MW1003A	234670	871920	36.49	36.1	154	-112.61	-117.61	5
36MW1010A	234896	872068	49.37	51.62	231	-171.13	-181.13	10
36MW1010B	234922	872071	50.63	49.95	165	-109.37	-114.37	5
36MW1010C	234896	872068	49.37	51.64	86	-31.13	-36.13	5
36MW1012A	234298	871824	38.04	37.24	149	-106.06	-111.06	5
36MW1012B	234304	871825	38.1	37.64	78	-34.8	-39.8	5
36MW1012C	234304	871825	38.1	37.72	23	20.5	15.5	5
36MW1014A	234611	871830	36.37	36.17	99	-57.13	-62.13	5
36MW1014B	234607	871829	36.16	35.98	23	18.06	13.06	5
36MW1038A	235573	872357	96.76	96.56	245	-142.94	-147.84	5
36MW1038B	235567	872350	96.95	96.18	204	-102.15	-106.95	5
36MW1038C	235578	872363	96.55	96.05	94	7.45	2.65	5
36MW1040A	235648	872945	64.54	64.32	219	-149.18	-153.98	5
36MW1040B	235647	872953	64.49	64.19	134	-63.99	-68.82	5
36MW1041A	235745	872659	93.88	93.12	224	-125.22	-130.02	5
36MW1041B	235745	872650	93.95	93.52	155	-55.75	-60.65	5
36MW1041C	235745	872650	93.95	93.51	135	-35.85	-40.75	5
36PZ1001	233707	871589	33.9	33.36	7	31.9	26.9	5
36PZ1002A	234086	871664	33.74	33.46	130	-91.26	-96.26	5
36PZ1002B	234086	871664	33.74	33.62	7	31.74	26.74	5
36PZ1003	234670	871920	36.72	36.44	7	34.72	29.72	5
36PZ1010	234896	872069	49.37	51.64	30	24.37	19.37	5
36SW0019 ⁽⁵⁾	233098	871632	29.48	N/A	N/A	N/A	N/A	N/A

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse

Notes:

1. The screen at 36EW0001 has a blank between -80.05 and -103.49 ft msl.
2. The effective screen length at 36EW0005 was shortened to 10 feet in October 2007 as part of the wellfield optimization.
3. The screen at 36EW0011 has a blank between -130.73 and -144.56 ft msl.
4. Extraction wells 36EW4020, 36EW4084, and 36EW4135 are decommissioned shallow wellpoints and are used for groundwater monitoring purposes only.
5. Locations have not been surveyed; location data is approximated.
6. The effective screen length at 36EW0001 was shortened to 10 feet in July 2011 as part of the wellfield optimization evaluation.

Key:

bgs = below ground surface

ft = feet

msl = mean sea level

N/A = not applicable

Table 2
FS-1 Groundwater and Surface Water Monitoring Results
FS-1 2011 Summary Letter Report

Location	Date	Laboratory Analyses		Water Quality Parameters					
		EDB ($\mu\text{g/L}$) MMCL = 0.02 ¹	Pb ($\mu\text{g/L}$) Action Level = 15 ²	Temp ($^{\circ}\text{C}$)	pH (std)	DO (mg/L)	SpC ($\mu\text{S/cm}$)	ORP (mV)	Turbidity (NTU)
Groundwater									
36EW0001	6/14/2011	0.013	NS	10.98	6.4	6.4	92	131.1	0
36EW0001	7/22/2011	0.018	NS	NM	NM	NM	NM	NM	NM
36EW0001	8/1/2011	0.014	NS	NM	NM	NM	NM	NM	NM
36EW0001	11/1/2011	0.021	NS	10.94	6.49	3.55	107	122.8	20.7
36EW0001	11/9/2011	ND	NS	10.52	6.54	5.72	92	158.8	0.6
36EW0001	12/6/2011	BRL	NS	10.96	6.15	7.1	98	146.4	19.3
36EW0005	6/14/2011	0.028	NS	11.66	6.26	7.84	90	133.7	2.9
36EW0005	12/6/2011	0.011	NS	10.50	6.22	10.39	96	127.1	17.1
36EW0011	6/14/2011	0.091	NS	11.99	6.4	6.88	94	153.1	0.2
36EW0011	12/6/2011	0.048	NS	11.19	5.94	7.36	102	145.0	17.9
36EW4020	6/23/2011	ND	NS	--	--	--	--	--	--
36EW4084	6/24/2011	ND	NS	--	--	--	--	--	--
36EW4135	6/24/2011	ND	NS	--	--	--	--	--	--
36MW0002	6/22/2011	NS	15	16.30	5.76	2.78	80	-45.3	1.4
36MW0007	6/22/2011	NS	8.1	16.05	5.65	3.77	74	-32.0	2.2
36MW0131A	6/23/2011	BRL	NS	--	--	--	--	--	--
36MW0131B	6/23/2011	ND	NS	--	--	--	--	--	--
36MW0131C	6/23/2011	ND	NS	--	--	--	--	--	--
36MW0132A	6/24/2011	ND	NS	--	--	--	--	--	--
36MW0132B	6/24/2011	ND	NS	--	--	--	--	--	--
36MW0132C	6/24/2011	ND	NS	--	--	--	--	--	--
36MW1001A	6/24/2011	ND	NS	--	--	--	--	--	--
36MW1001B	6/24/2011	0.019	NS	--	--	--	--	--	--
36MW1003A	6/24/2011	ND	NS	--	--	--	--	--	--
36MW1010A	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1010B	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1010C	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1012A	7/11/2011	ND	NS	--	--	--	--	--	--
36MW1012B	6/23/2011	BRL	NS	--	--	--	--	--	--
36MW1012C	6/23/2011	ND	NS	--	--	--	--	--	--
36MW1014A	6/23/2011	ND	NS	--	--	--	--	--	--
36MW1014B	6/23/2011	ND	NS	--	--	--	--	--	--
36MW1038A	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1038B	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1038C	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1040A	6/22/2011	0.023	NS	--	--	--	--	--	--
36MW1040B	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1041A	6/22/2011	0.212	NS	--	--	--	--	--	--
36MW1041B	6/22/2011	ND	NS	--	--	--	--	--	--
36MW1041C	6/22/2011	ND	NS	--	--	--	--	--	--
36PZ1001	6/24/2011	ND	NS	--	--	--	--	--	--
36PZ1002A	6/24/2011	ND	NS	--	--	--	--	--	--
36PZ1002B	6/24/2011	ND	NS	--	--	--	--	--	--
36PZ1003	6/24/2011	ND	NS	--	--	--	--	--	--
36PZ1010	6/28/2011	ND	NS	10.88	5.73	2.27	99	-56.5	2
Surface Water									
36SW0019	8/23/2011	0.011J ^{3,4}	NS	--	--	--	--	--	--

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse

Notes :

1. MMCL from Massachusetts Department of Environmental Protection (MassDEP) web page, <http://www.mass.gov/dep/water/dwstand.pdf>.
2. Value reported is the treatment technique action level for lead in drinking water systems from U.S. Environmental Protection Agency (EPA) web page, <http://www.epa.gov/safewater/consumer/pdf/mcl.pdf>.
3. EDB screening-level risk based concentration for imminent human health risk (10^{-3} risk) = 6.5 $\mu\text{g/L}$: *Preliminary Screening-Level Human Health Risk Evaluation for Fuel Spill-1 Surface Water and Treatment System Data* ; Appendix D of *Final Fuel Spill-1 2002 Annual System Performance and Ecological Impact Monitoring Report* , dated May 2003.
4. EDB screening-level ecological benchmark for surface water = 31 $\mu\text{g/L}$: *Final Ethylene Dibromide Derivation of Aquatic Screening Benchmarks*, dated November 1998.

Bold values represent EDB concentrations above the MMCL .

--: Sample collected through use of passive diffusion bag sampler; water quality parameter collection not performed.

Key:

°C = degrees Celsius

DO = dissolved oxygen

EDB = ethylene dibromide

mg/L = milligrams per liter

MMCL = Massachusetts Maximum Contaminant Level

mV = millivolts

ND = not detected

NM = not measured, water quality parameters not collected

std = standard units

Temp = temperature

J = estimated

$\mu\text{g/L}$ = micrograms per liter

$\mu\text{S/cm}$ = microsiemens per centimeter

Table 3
FS-1 Meeting Presentations
FS-1 2011 Summary Letter Report

Technical Update Meetings

16 March 2011	FS-1 2010 Annual SPEIM Data Presentation and ETD Optimization
11 May 2011	FS-1 2010 Annual SPEIM Data Presentation Follow Up
11 May 2011	FS-1 Surface Water Monitoring Network Optimization
13 July 2011	FS-1 2010 Annual SPEIM Data Presentation Project Note Sign Off
13 July 2011	FS-1 Surface Water Monitoring Network Optimization
29 September 2011	FS-1 Surface Water Monitoring Network Optimization Follow Up and Project Note Sign Off
17 November 2011	FS-1 2011 Annual SPEIM Data Presentation and ETD System Optimization Update

MMR Cleanup Team (MMRCT)

11 May 2011	FS-1 Plume Update
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SMB Meetings

No presentations

Conferences

No presentations

Table 4
FS-1 Treatment Plant Sampling Results
FS-1 2011 Summary Letter Report

Month of Event	Sample Date	Location Identification	Sample Location	Laboratory Analyses	Water Quality Parameters					
				EDB (µg/L) MMCL = 0.02	Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH (std)	ORP (mV)	Turbidity (NTU)
February	25-Jan-11	36PLT02001	Combined Influent	0.063	--	--	--	--	--	--
		36PLT02003	Post GAC 102 Lag	BRL	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
March	25-Feb-11	36PLT02001	Combined Influent	0.059	--	--	--	--	--	--
		36PLT02003	Post GAC 102 Lag	0.015	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
Carbon was exchanged in CF101 on 16 March 2011. Following the exchange, CF102 was aligned as the lead GAC vessel, CF103 was aligned as the lag vessel, and CF101 became the polishing vessel.										
April	25-Mar-11	36PLT02001	Combined Influent	0.058	--	--	--	--	--	--
		36PLT02004	Post GAC 103 Lag	ND	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
May	25-Apr-11	36PLT02001	Combined Influent	0.062	--	--	--	--	--	--
		36PLT02004	Post GAC 103 Lag	ND	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
June	25-May-11	36PLT02001	Combined Influent	0.048	10.06	89	6.17	6.23	165.8	0
		36PLT02004	Post GAC 103 Lag	ND	10.05	88	5.16	6.17	208.0	0
		36PLT02005	Plant Effluent	ND	10.07	88	4.74	6.13	189.3	0
July	27-Jun-11	36PLT02001	Combined Influent	0.055	--	--	--	--	--	--
		36PLT02004	Post GAC 103 Lag	0.010	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
August	27-Jul-11	36PLT02001	Combined Influent	0.054	--	--	--	--	--	--
		36PLT02004	Post GAC 103 Lag	BRL	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--

Table 4
FS-1 Treatment Plant Sampling Results
FS-1 2011 Summary Letter Report

Month of Event	Sample Date	Location Identification	Sample Location	Laboratory Analyses EDB (µg/L) MMCL = 0.02	Water Quality Parameters					
					Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH (std)	ORP (mV)	Turbidity (NTU)
September	25-Aug-11	36PLT02001	Combined Influent	0.044	--	--	--	--	--	--
		36PLT02004	Post GAC 103 Lag	0.012	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
Carbon was exchanged in CF102 on 15 September 2011. Following the exchange, CF103 was aligned as the lead GAC vessel, CF101 was aligned as the lag vessel, and CF102 became the polishing vessel.										
October	27-Sep-11	36PLT02001	Combined Influent	0.040	--	--	--	--	--	--
		36PLT02002	Post GAC 101 Lag	ND	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
November	27-Oct-11	36PLT02001	Combined Influent	0.049	--	--	--	--	--	--
		36PLT02002	Post GAC 101 Lag	ND	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--
December	28-Nov-11	36PLT02001	Combined Influent	0.045	10.22	83	5.93	6.21	179.1	0
		36PLT02002	Post GAC 101 Lag	ND	NM ¹	NM ¹	NM ¹	NM ¹	NM ¹	NM ¹
		36PLT02005	Plant Effluent	ND	10.26	82	4.58	6.18	169.5	0
January	27-Dec-11	36PLT02001	Combined Influent	0.036	--	--	--	--	--	--
		36PLT02002	Post GAC 101 Lag	BRL	--	--	--	--	--	--
		36PLT02005	Plant Effluent	ND	--	--	--	--	--	--

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse

Notes:

Bold values represent EDB concentration above MMCL.

NM¹ = water quality parameter collection at the midpoint sample port was omitted.

Water quality parameters (pH, temperature, dissolved oxygen, conductivity, turbidity and oxidation/reduction potential) are measured semiannually at influent, post-GAC at each active GAC vessel, and plant effluent sampling locations. The measurements are taken using a flow-thru cell and the Yellow Springs Instrument (YSI).

--: Water quality parameters were not collected.

Key:

BRL = below reporting limit

mg/L = milligrams per liter

ORP = oxidation-reduction potential

°C = degrees Celsius

MMCL = Massachusetts Maximum Contaminant Level

SpC = specific conductance

DO = dissolved oxygen

mV = millivolts

Temp = temperature

EDB = ethylene dibromide

ND = not detected

µg/L = micrograms per liter

GAC = granular activated carbon

NTU = nephelometric turbidity units

µS/cm = microseimens per centimeter

Table 5
FS-1 Treatment System Flow Rates
FS-1 2011 Summary Letter Report

Week Ending	36EW0001 Flow Rate (gpm)	36EW0005 Flow Rate (gpm)	36EW0007 Flow Rate (gpm)	36EW0011 Flow Rate (gpm)	Treatment Plant Total Flow (gpm)
2007 Scenario 01					
5-Jan-11	90	175	N/A	250	515
12-Jan-11	90	175	N/A	250	515
19-Jan-11	90	175	N/A	250	515
26-Jan-11	90	175	N/A	250	515
2-Feb-11	89	174	N/A	248	512
9-Feb-11	90	175	N/A	250	515
16-Feb-11	90	175	N/A	250	515
23-Feb-11	90	175	N/A	250	515
2-Mar-11	90	175	N/A	250	515
9-Mar-11	87	147	N/A	250	484
16-Mar-11	90	174	N/A	247	511
23-Mar-11	90	175	N/A	250	515
30-Mar-11	90	175	N/A	250	515
6-Apr-11	90	175	N/A	250	514
13-Apr-11	90	175	N/A	250	515
20-Apr-11	90	175	N/A	250	515
27-Apr-11	90	175	N/A	250	515
4-May-11	90	176	N/A	250	516
11-May-11	90	175	N/A	250	515
18-May-11	89	174	N/A	248	512
25-May-11	90	176	N/A	250	516
1-Jun-11	90	175	N/A	250	515
8-Jun-11	90	175	N/A	250	515
15-Jun-11	90	175	N/A	250	515
22-Jun-11	89	172	N/A	246	507
29-Jun-11	87	169	N/A	200	455
6-Jul-11	90	175	N/A	250	515
13-Jul-11	81	174	N/A	249	505
20-Jul-11	4	175	N/A	250	429
27-Jul-11	54	105	N/A	150	310
3-Aug-11	83	162	N/A	231	477
10-Aug-11	90	174	N/A	249	514
17-Aug-11	90	175	N/A	248	513
24-Aug-11	89	172	N/A	246	508
31-Aug-11	54	105	N/A	150	309
7-Sep-11	90	175	N/A	250	515
14-Sep-11	90	175	N/A	250	514
21-Sep-11	90	174	N/A	249	513
28-Sep-11	90	175	N/A	250	515
5-Oct-11	90	175	N/A	250	515
12-Oct-11	90	175	N/A	250	515
19-Oct-11	90	175	N/A	250	515
26-Oct-11	55	172	N/A	245	472
2-Nov-11	20	130	N/A	186	335
9-Nov-11	55	175	N/A	250	471
16-Nov-11	45	175	N/A	250	469
23-Nov-11	45	175	N/A	250	463
30-Nov-11	31	120	N/A	171	324
7-Dec-11	45	175	N/A	250	469

Table 5
FS-1 Treatment System Flow Rates
FS-1 2011 Summary Letter Report

Week Ending	36EW0001 Flow Rate (gpm)	36EW0005 Flow Rate (gpm)	36EW0007 Flow Rate (gpm)	36EW0011 Flow Rate (gpm)	Treatment Plant Total Flow (gpm)
14-Dec-11	41	160	N/A	228	430
21-Dec-11	44	172	N/A	246	463
28-Dec-11	45	175	N/A	250	470
Average Flow Rate (gpm)	86*	169	N/A	241	487
Optimized Design Flow Rate (gpm) (2007 Scenario 01)	90	175	N/A	250	515
Percent of Optimized Design Rate	95	97	N/A	96	95

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse.

Notes:

Flow rates presented are weekly averages.

Any downtimes due to routine and non-routine operations and maintenance activities were included in the average flow rates.

*Average does not include reduced flows at 36EW0001, which were implemented on October 2011 as part of on-going flow testing.

Key:

gpm = gallons per minute

N/A = not applicable. 36EW0007 taken offline on 01 October 2007.

Table 6
FS-1 Treatment System Downtime Summary
FS-1 2011 Summary Letter Report

Date	Hours Off-Line	Reason
3/9/2011	4.32	Plant tripped off due to a power blip.
6/16/2011	2.58	Plant intentionally shut down for energy curtailment event.
6/28/2011	5.83	36EW0011 variable frequency drive trip system.
7/13/2011	176.25	36EW0001 off for well maintenance.
7/22/2011	65.50	Plant intentionally shut down for energy curtailment event.
8/2/2011	12.47	Plant tripped off due to a power failure during the thunder storms.
8/24/2011	2.42	Plant tripped off due to a power blip.
8/26/2011	68.25	Hurricane preparedness.
10/24/2011	193.72	36EW0001 intentionally shutoff for low flow sample after stabilization.
10/29/2011	32.42	Plant tripped off due to power failure.
11/26/2011	52.75	Plant tripped due to a power failure.
12/12/2011	13.67	Plant intentionally shut down for energy curtailment event.
12/19/2011	2.50	Plant intentionally shut down for energy curtailment event.

Table 7
FS-1 Treatment System Mass Removal Summary
FS-1 2011 Summary Letter Report

Date	36EW0001		36EW0005		36EW0007 ⁽³⁾		36EW0011		Total EDB Removed (Extraction Well Sampling)		Total EDB Removed (Plant Influent Sampling)	
	Incremental Mass Removed (lbs)	Cumulative Mass Removed (lbs)	Incremental Mass Removed (lbs)	Cumulative Mass Removed (lbs)	Incremental Mass Removed (lbs)	Cumulative Mass Removed (lbs)						
Jan-11	0.000	0.803	0.002	1.407	0.000	1.095	0.009	3.832	0.012	7.137	0.011	7.458
Feb-11	0.000	0.803	0.002	1.409	0.000	1.095	0.008	3.840	0.010	7.147	0.010	7.468
Mar-11	0.000	0.803	0.002	1.411	0.000	1.095	0.009	3.848	0.011	7.157	0.011	7.479
Apr-11	0.000	0.804	0.002	1.413	0.000	1.095	0.008	3.857	0.011	7.169	0.011	7.490
May-11	0.000	0.804	0.002	1.415	0.000	1.095	0.009	3.865	0.011	7.179	0.010	7.500
Jun-11	0.000	0.805	0.002	1.417	0.000	1.095	0.008	3.873	0.010	7.190	0.009	7.510
Jul-11	0.000	0.805	0.001	1.418	0.000	1.095	0.007	3.880	0.009	7.198	0.009	7.519
Aug-11	0.000	0.805	0.001	1.420	0.000	1.095	0.006	3.886	0.008	7.206	0.008	7.527
Sep-11	0.001	0.806	0.001	1.421	0.000	1.095	0.006	3.892	0.008	7.214	0.008	7.534
Oct-11	0.000	0.806	0.001	1.422	0.000	1.095	0.005	3.898	0.007	7.221	0.008	7.542
Nov-11	0.000	0.807	0.001	1.423	0.000	1.095	0.004	3.902	0.005	7.227	0.007	7.550
Dec-11	0.000	0.807	0.001	1.423	0.000	1.095	0.004	3.906	0.005	7.231	0.007	7.556

EDB Removed (lbs) by Final ETD System (January 2011 - December 2011)	0.11
EDB Removed (lbs) by Final ETD System since startup (September 2003 - December 2011)¹	7.56
EDB Removed (lbs) by Interim ETD System (April 1999 - October 2002)²	10.31
Total EDB Mass Removed (lbs) between April 1999 and December 2011	17.87

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse

Notes:

1. Final ETD system began operation on 30 September 2003.
2. Interim ETD system operated between April 1999 and October 2002.
3. 36EW0007 was turned off on 01 October 2007 as part of the ETD system optimization.

Key:

ETD = extraction, treatment, and discharge

EDB = ethylene dibromide

lbs = pounds

Table 8
FS-1 Remedial Systems Electrical Consumption and Associated Air Emissions
FS-1 2011 Summary Letter Report

Volume of Groundwater Treated (million gallons)		1/1/2011 to 12/31/2011	System Startup (4/1999) to 12/31/2011 ⁴
		256	3,825
Groundwater COC Mass Removal (pounds)		0.11	17.87
Electrical Usage (MWh)		274	4,521
Estimated Air Emissions ¹ (based on electrical usage)	CO ₂ (tons)	179	2,997
	NOx (lbs)	386	6,346
	PM-10 (lbs)	22	358
	SO ₂ (lbs)	1,030	16,487
	VOCs (lbs)	14	225
Estimated Reduction in Air Emissions due to Green Power Purchases ²	CO ₂ (tons)	90	403
	NOx (lbs)	193	751
	PM-10 (lbs)	11	36
	SO ₂ (lbs)	515	1,509
	VOCs (lbs)	7	29
Estimated Reduction in Air Emissions due to MMR Wind Turbine Operation ³	CO ₂ (tons)	85	111
	NOx (lbs)	182	240
	PM-10 (lbs)	10.4	13.7
	SO ₂ (lbs)	486	639
	VOCs (lbs)	6.4	8.4
Estimated Total Air Emissions with consideration of Green Power Purchases and MMR Wind Turbine Operation	CO ₂ (tons)	5	2,483
	NOx (lbs)	11	5,355
	PM-10 (lbs)	1	308
	SO ₂ (lbs)	29	14,339
	VOCs (lbs)	0	187

Notes:

1) The estimated air emissions presented in this table are based on the assumption that until 4/30/2009, the power used to operate the MMR remedial systems was provided by the Mirant Canal Station power plant in Sandwich, MA. This power plant primarily produced electricity generated by the combustion of fuel oil and has been off-line since 5/1/2009. Starting on 5/1/2009, air emissions are based on electricity generated by the average mix of power sources in Massachusetts. Air emissions were calculated using MMR utility data from AFCEE's Metrix 4 Utility Accounting Software

(<http://www.abraxasenergy.com/metrix4.php>) and emission factors obtained from the following websites:

<http://www.csqnetwork.com/electricpowerpolcalc.html>

<http://www.metrixcentral.com/EmissionsCalculator/Emissions%20Factors%202004.pdf>

2) Emissions offset by purchases of electricity from renewable sources beginning 7/1/2008.

3) Emissions offset by operation of AFCEE-owned wind turbines beginning on 12/2/2009 (Wind I) and 11/1/2011 (Wind II).

4) System was not operational between October 2002 and September 2003, system was down due to a fire that consumed the original plant.

Key:

COC = contaminant of concern

CO₂ = carbon dioxide

FS-1 = Fuel Spill-1

lbs = pounds

MMR = Massachusetts Military Reservation

MWh = megawatt hours

NO_x = nitrogen oxides

PM-10 = particulate matter with a diameter of 10 micrometers or less

SO₂ = sulfur dioxide

VOCs = volatile organic compounds

ATTACHMENT A

Comparison of Detected Concentrations in FS-1 Groundwater, Surface Water, and Treatment Plant Samples to Applicable Groundwater and Surface Water Standards

Attachment A
Comparison of Detected Concentrations in FS-1 Groundwater, Surface Water, and Treatment Plant Samples to Applicable Groundwater and Surface Water Standards
FS-1 2011 Summary Letter Report

Location	Date	Sample Elevation (ft msl)	Matrix	Test	Analyte	Result	DL	RL	Standard	Type ^{1,2,3}	Standard Exceeded?
36EW0001	6/14/2001	-66.98	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.013	0.005	0.01	0.02	MMCL	No
36EW0001	7/22/2011	-66.98	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.018	0.005	0.01	0.02	MMCL	No
36EW0001	8/1/2011	-66.98	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.014	0.005	0.009	0.02	MMCL	No
36EW0001	11/1/2011	-66.98	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.021	0.005	0.01	0.02	MMCL	Yes
36EW0001	12/6/2011	-66.98	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
36EW0005	6/14/2011	-117.53	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.028	0.005	0.01	0.02	MMCL	Yes
36EW0005	12/6/2011	-143.38	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.011	0.005	0.01	0.02	MMCL	No
36EW0011	6/14/2011	-119.66	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.091	0.005	0.01	0.02	MMCL	Yes
36EW0011	12/6/2011	-119.66	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.048	0.005	0.01	0.02	MMCL	Yes
36MW0002	6/22/2011	54.29	WG	SW6020A	LEAD	15	0.15	1	15	Action Level ^a	No
36MW0007	6/22/2011	56.20	WG	SW6020A	LEAD	8.1	0.15	1	15	Action Level ^a	No
36MW0131A	6/23/2011	-130.35	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
36MW1001B	6/24/2011	-62.87	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.019	0.005	0.01	0.02	MMCL	No
36MW1012B	6/23/2011	-37.30	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
36MW1040A	6/22/2011	-151.58	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.023	0.005	0.009	0.02	MMCL	Yes
36MW1041A	6/22/2011	-127.62	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.212	0.01	0.019	0.02	MMCL	Yes
36PLT02001 (INF)	1/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.063	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	2/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.059	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	3/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.058	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	4/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.062	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	5/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.048	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	6/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.055	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	7/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.054	0.005	0.011	0.02	MMCL	Yes
36PLT02001 (INF)	8/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.044	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	9/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.04	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	10/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.049	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	11/28/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.045	0.005	0.01	0.02	MMCL	Yes
36PLT02001 (INF)	12/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.036	0.005	0.01	0.02	MMCL	Yes
36PLT02002 (MID)	12/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
36PLT02003 (MID)	1/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
36PLT02003 (MID)	2/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.015	0.005	0.01	0.02	MMCL	No
36PLT02004 (MID)	6/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.01	0.005	0.01	0.02	MMCL	No

Attachment A

Comparison of Detected Concentrations in FS-1 Groundwater, Surface Water, and Treatment Plant Samples to Applicable Groundwater and Surface Water Standards
FS-1 2011 Summary Letter Report

Location	Date	Sample Elevation (ft msl)	Matrix	Test	Analyte	Result	DL	RL	Standard	Type ^{1,2,3}	Standard Exceeded?
						All Units = $\mu\text{g/L}$					
36PLT02004 (MID)	7/27/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.006	0.011	0.02	MMCL	No
36PLT02004 (MID)	8/25/2011	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012	0.005	0.01	0.02	MMCL	No
36SW0019	8/23/2011	N/A	WS	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.011 J	0.005	0.01	6.5 ^(a) /31 ^(b)	RBC/ECO	No

Data Source: AFCEE, February 2012, MMR-AFCEE Data Warehouse

Notes:

1. MMCL from Massachusetts Department of Environmental Protection (MassDEP) web page, <http://www.mass.gov/dep/water/dwstand.pdf>.
2. EDB screening-level risk based concentration for imminent human health risk (10^3 risk) = 6.5 $\mu\text{g/L}$: *Preliminary Screening-Level Human Health Risk Evaluation for Fuel Spill-1 Surface Water and Treatment System Data*; Appendix D of *Final Fuel Spill-1 2002 Annual System Performance and Ecological Impact Monitoring Report*, dated May 2003.
3. EDB screening-level ecological benchmark for surface water: *Final Ethylene Dibromide Derivation of Aquatic Screening Benchmarks*, dated November 1998.
4. Value reported is the treatment technique action level for lead in drinking water systems from Environmental Protection Agency (EPA) web page, <http://www.epa.gov/safewater/consumer/pdf/mcl.pdf>.

Key:

BRL = below reporting limit

N/A = information not applicable

DL = detection limit

RBC = human health screening-level risk based concentration (risk = 10^3)

ECO = screening-level ecological benchmark

RL = reporting limit

EDB = ethylene dibromide

WA = borehole screening sample

ft msl = feet mean sea level

WG = groundwater sample

INF = treatment plant influent

WS = surface water sample

J = estimated value

WW = plant water sample

MID = treatment plant midpoint sample

$\mu\text{g/L}$ = micrograms per liter

MMCL = Massachusetts Maximum Contaminant Level

ATTACHMENT B

FS-1 2011 SLR

Data Summary Report

Attachment B
Data Summary Report
Fuel Spill-1 2011 Summary Letter Report

INTRODUCTION

The objective of this data summary report (DSR) is to assess the data quality of analytical results for samples collected for the Fuel Spill-1 System Performance and Ecological Impact Monitoring (SPEIM) Program at the Massachusetts Military Reservation (MMR) as presented in the *Fuel Spill-1 2011 Summary Letter Report*. This report is intended as a general data quality assessment designed to summarize data issues.

ANALYTICAL DATA

This DSR covers 45 groundwater samples with three field duplicate samples, one surface water sample with one field duplicate sample, and 36 plant samples. Field duplicates are not required for treatment facility plant samples. These samples were reported under 25 sample delivery groups. Samples were collected between 25 January 2011 and 27 December 2011. The analyses were performed by Analytics Environmental Laboratory LLC (ANAP) in Portsmouth, New Hampshire and TriMatrix Laboratories (TMLG) in Grand Rapids, Michigan. Samples were collected and shipped by overnight carrier to TMLG and either shipped by overnight carrier or delivered by courier to ANAP for analysis. Samples were analyzed for the analyte/method provided in Table B-1.

Table B-1
Analytical Parameter

Parameter	Method	Laboratory
Ethylene Dibromide (EDB)	E504.1	ANAP
Lead	SW6020A	TMLG

E = Environmental Protection Agency (EPA) Method

SW = SW 846 Test Methods for Evaluating Solid Waste, 3rd Edition, Revision 1, 2007

The data were assessed using the MMR SPEIM Quality Assurance Project Plan (QAPP)¹.

The assessment included a review of the following:

¹ AFCEE. 2011 (August). *AFCEE MMR SPEIM/LTM/O&M Program Quality Assurance Project Plan*. 404929-Program-Multiple-QAPP-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis ANG Base, MA.

- Chain-of-Custody documentation
- Holding-time compliance
- Required quality control (QC) samples at the specified frequencies
- Method blanks
- Laboratory control spiking samples
- Surrogate spike recoveries
- Initial and continuing calibration information and other method-specific criteria as defined by the SPEIM QAPP

Field samples were reviewed to ascertain field compliance and data quality issues. This included a review of equipment blanks (EB) and field duplicates.

Data were carried through data validation as described in the SPEIM QAPP and data flags were assigned according to the SPEIM QAPP. These flags, and the reason for each flag, were entered into the electronic database and can be found in Table B-2 (located at the end of this attachment). Multiple flags are routinely applied to specific sample method/matrix/analyte combinations, but there is only one final flag. A final flag is applied to the data, and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

The data flags are listed in the SPEIM QAPP and are defined as follows:

- J = Analyte was present but the reported value may not be accurate or precise (estimated).
- R = Analyte result was unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
- U = Analyte was not detected at the specified detection limit.
- UJ = Analyte was not detected and the specified detection limit may not be accurate or precise (estimated).

FINDINGS

The summaries of the data validation findings are contained in the following subsections and Table B-2.

Holding Times

All holding-time criteria were met.

Calibration

Initial and continuing calibrations were analyzed as required in every analytical batch and were in control. No calibration flags were applied.

Method Blanks

Method blanks were analyzed at the required frequency for each method. No method blank flags were applied.

Field Blanks

EBs were collected and analyzed at the required frequency. No field blank flags were applied.

Field Duplicates

Field duplicates were collected as required, and precision was acceptable. No field duplicate flags were applied.

Matrix Spike Samples

As presented in the SPEIM QAPP Table 3-4, matrix spikes and matrix spike duplicates were not required to be collected for routine monitoring samples. No non-routine samples were collected during this time period.

Surrogates

Surrogate recoveries met the method SPEIM QAPP criteria overall. Two samples had surrogate recoveries less than the lower control limit for method E504.1. The detected results were qualified as estimated values and flagged “J”.

Laboratory Control Samples

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed as required and were in control. No LCS/LCSD flags were applied.

Confirmation Results

Confirmation samples were analyzed as required by method E504.1 and no data required qualification.

Chain of Custody

No chain of custody anomalies were noted in the review.

Overall Assessment

The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decision-making process. The procedures for assessing the precision, accuracy, representativeness, completeness, and comparability parameters (PARCC) are addressed in the SPEIM QAPP. The following summary highlights the PARCC findings for the above-defined events:

1. The completeness goal for valid usable data is 95 percent for aqueous samples and completeness for EDB and lead samples was 100 percent. The routinely acceptable performance of field and laboratory QC indicators (field duplicates, field blanks, laboratory blanks, surrogate spikes, LCS/LCSDs, and calibrations) shows that the precision and accuracy of the data met project objectives.
3. Sample results are representative and comparable to field conditions and past historical data because the field sampling and laboratory analyses were performed using standardized and documented procedures as defined in project documents. In addition, all results were reported with industry standard units.

Table B-2
Validation Flags^a

Field ID	Method	Analyte	Final Result (µg/L)	Final Flag	Reason
CHPN00019-A0811	E504.1	1,2-Dibromoethane (EDB)	0.011	J	Sur<LCL
CHPN10019-A0811	E504.1	1,2-Dibromoethane (EDB)	0.009	J	Sur<LCL

Notes:

^aField samples and field duplicates only.

Table sorted by Reason, Analyte and Field ID.

Key:

J = estimated value

Sur < LCL = Surrogate recovery less than lower limit

µg/L = micrograms per liter

Attachment B
Analytical Laboratory Results, January - December 2011
Fuel Spill-1 2011 Summary Letter Report

Location	Date	Sample ID	Depth	Type	Matrix	Test	Prep	Analyte	Result	DL	RL	Units	Qual
36EW0001	12/6/2011	CHPN10001-S1211	123.74	FD1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	J
36EW0001	12/6/2011	CHPN00001-S1211	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	J
36EW0001	6/14/2011	CHPN00001-A0611	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.013	0.005	0.01	µg/L	
36EW0001	8/1/2011	CHTD00001-O0711	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.014	0.005	0.009	µg/L	
36EW0001	7/22/2011	CHTD00001-O0411	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.018	0.005	0.01	µg/L	
36EW0001	11/1/2011	CHTD00001-O1011	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.021	0.005	0.01	µg/L	
36EW0001	11/9/2011	CHTD00001-O1111	123.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	U
36EW0005	12/6/2011	CHPN00005-S1211	181	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.011	0.005	0.01	µg/L	
36EW0005	6/14/2011	CHPN00005-A0611	181	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.028	0.005	0.01	µg/L	
36EW0011	12/6/2011	CHPN00011-S1211	213.17	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.048	0.005	0.01	µg/L	
36EW0011	6/14/2011	CHPN00011-A0611	213.17	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.091	0.005	0.01	µg/L	
36EW4020	6/23/2011	CHPN04020-A0611DIF	18.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36EW4084	6/24/2011	CHPN04084-A0611DIF	19	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36EW4135	6/24/2011	CHPN04135-A0611DIF	18.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36MW0002	6/22/2011	CHPN00002-A0611	51.46	N1	WG	SW6020A	SW3020A	LEAD	15	0.15	1	µg/L	
36MW0007	6/22/2011	CHPN10007-A0611	51	FD1	WG	SW6020A	SW3020A	LEAD	8	0.15	1	µg/L	
36MW0007	6/22/2011	CHPN00007-A0611	51	N1	WG	SW6020A	SW3020A	LEAD	8.1	0.15	1	µg/L	
36MW0131A	6/23/2011	CHPN0131A-A0611DIF	182.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	
36MW0131B	6/23/2011	CHPN0131B-A0611DIF	136.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW0131C	6/23/2011	CHPN0131C-A0611DIF	87.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW0132A	6/24/2011	CHPN0132A-A0611DIF	187.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36MW0132B	6/24/2011	CHPN0132B-A0611DIF	137.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW0132C	6/24/2011	CHPN0132C-A0611DIF	80.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1001A	6/24/2011	CHPN0001A-A0611DIF	147.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1001B	6/24/2011	CHPN0001B-A0611DIF	97.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.019	0.005	0.01	µg/L	
36MW1003A	6/24/2011	CHPN0003A-A0611DIF	151.6	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36MW1010A	6/22/2011	CHPN0010A-A0611DIF	225.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1010B	6/22/2011	CHPN0010B-A0611DIF	162.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36MW1010C	6/22/2011	CHPN0010C-A0611DIF	83	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1012A	7/11/2011	CHPN0012A-A0611DIF	146.6	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1012B	6/23/2011	CHPN0012B-A0611DIF	75.4	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	
36MW1012C	6/23/2011	CHPN0012C-A0611DIF	20.1	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1014A	6/23/2011	CHPN0014A-A0611DIF	96	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1014B	6/23/2011	CHPN0014B-A0611DIF	20.6	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1038A	6/22/2011	CHPN0038A-A0611DIF	242.15	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1038B	6/22/2011	CHPN0038B-A0611DIF	201.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1038C	6/22/2011	CHPN0038C-A0611DIF	91.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1040A	6/22/2011	CHPN1040A-A0611DIF	216.12	FD1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.019	0.005	0.009	µg/L	
36MW1040A	6/22/2011	CHPN0040A-A0611DIF	216.12	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.023	0.005	0.009	µg/L	
36MW1040B	6/22/2011	CHPN0040B-A0611DIF	130.9	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36MW1041A	6/22/2011	CHPN0041A-A0611DIF	221.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.212	0.01	0.019	µg/L	
36MW1041B	6/22/2011	CHPN0041B-A0611DIF	152.15	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36MW1041C	6/22/2011	CHPN0041C-A0611DIF	132.25	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36PLT02001	12/27/2011	CHTD02001-M0112		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.036	0.005	0.01	µg/L	
36PLT02001	9/27/2011	CHTD02001-M1011		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.04	0.005	0.01	µg/L	
36PLT02001	8/25/2011	CHTD02001-M0911		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.044	0.005	0.01	µg/L	
36PLT02001	11/28/2011	CHTD02001-M1211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.045	0.005	0.01	µg/L	
36PLT02001	5/25/2011	CHTD02001-M0611		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.048	0.005	0.01	µg/L	
36PLT02001	10/27/2011	CHTD02001-M1111		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.049	0.005	0.01	µg/L	
36PLT02001	7/27/2011	CHTD02001-M0811		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.054	0.005	0.011	µg/L	
36PLT02001	6/27/2011	CHTD02001-M0711		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.055	0.005	0.01	µg/L	

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Location	Date	Sample ID	Depth	Type	Matrix	Test	Prep	Analyte	Result	DL	RL	Units	Qual
36PLT02001	3/25/2011	CHTD02001-M0411		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.058	0.005	0.01	µg/L	
36PLT02001	2/25/2011	CHTD02001-M0311		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.059	0.005	0.01	µg/L	
36PLT02001	4/25/2011	CHTD02001-M0511		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.062	0.005	0.01	µg/L	
36PLT02001	1/25/2011	CHTD02001-M0211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.063	0.005	0.01	µg/L	
36PLT02002	12/27/2011	CHTD02002-M0112		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	J
36PLT02002	9/27/2011	CHTD02002-M1011		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02002	10/27/2011	CHTD02002-M1111		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02002	11/28/2011	CHTD02002-M1211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02003	1/25/2011	CHTD02003-M0211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	
36PLT02003	2/25/2011	CHTD02003-M0311		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.015	0.005	0.01	µg/L	
36PLT02004	7/27/2011	CHTD02004-M0811		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.006	0.011	µg/L	J
36PLT02004	6/27/2011	CHTD02004-M0711		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.01	0.005	0.01	µg/L	
36PLT02004	8/25/2011	CHTD02004-M0911		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012	0.005	0.01	µg/L	
36PLT02004	3/25/2011	CHTD02004-M0411		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02004	4/25/2011	CHTD02004-M0511		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36PLT02004	5/25/2011	CHTD02004-M0611		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	1/25/2011	CHTD02005-M0211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	2/25/2011	CHTD02005-M0311		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	3/25/2011	CHTD02005-M0411		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	4/25/2011	CHTD02005-M0511		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.009	µg/L	
36PLT02005	5/25/2011	CHTD02005-M0611		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	6/27/2011	CHTD02005-M0711		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PLT02005	7/27/2011	CHTD02005-M0811		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02005	8/25/2011	CHTD02005-M0911		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02005	9/27/2011	CHTD02005-M1011		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02005	10/27/2011	CHTD02005-M1111		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02005	11/28/2011	CHTD02005-M1211		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PLT02005	12/27/2011	CHTD02005-M0112		N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
36PZ1001	6/24/2011	CHPN0101-A0611DIF	4.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PZ1002A	6/24/2011	CHPN0002A-A0611DIF	127.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PZ1002B	6/24/2011	CHPN0002B-A0611DIF	4.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PZ1003	6/24/2011	CHPN0003-A0611DIF	4.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36PZ1010	6/28/2011	CHPN01010-A0611	27.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	
36SW0019	8/23/2011	CHPN01019-A0811		FD1	WS	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.009	µg/L	J
36SW0019	8/23/2011	CHPN00019-A0811		N1	WS	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.011	0.005	0.01	µg/L	J

Data Source: AFCEE, March 2012, MMR-AFCEE Data Warehouse

Key:

DL = detection limit

U = undetected

FD1 = field duplicate

WG = groundwater

J = estimated value

WW = wastewater

N1 = native sample

WS = surface water

ND = nondetect

µg/L = micrograms per liter

RL = reporting limit

ATTACHMENT C

FS-1 Project Notes

**FS-1 2010 Annual SPEIM Data Presentation
(Oct 2009–Dec 2010) and ETD System Optimization**
404929-SPEIM-FS1-PRJNOT-001

FS-1 2011 Surface Water Monitoring Network Optimization
404929-SPEIM-FS1-PRJNOT-002

**FS-1 2011 Annual SPEIM Data Presentation (Jan 2011-June 2011), ETD System
Optimization Update and Source Area Groundwater Monitoring Update**
420005-SPEIM-FS1-PRJNOT-001



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<p>Confirmation Of:</p> <p><input type="checkbox"/> Meeting</p> <p><input type="checkbox"/> Change Notice</p> <p><input checked="" type="checkbox"/> General Project Note</p>	<p>Date Held: 13 July 2011</p> <p>Location: Large IRP Conference Room</p> <p>Date Issued: 18 July 2011</p> <p>Recorded By: Mark Hilyard</p>
<p>Subject:</p> <p>FS-1 2010 ANNUAL SPEIM DATA PRESENTATION (OCT 2009 – DEC-2010) AND ETD SYSTEM OPTIMIZATION EPA OU-06</p>	<p>Issued By: Nigel Tindall</p> <p></p> <p>CH2M HILL TECHNICAL SERVICES GROUP MANAGER</p>
ITEM REMARKS	
<p>1.0 INTRODUCTION</p> <p>This project note summarizes the Fuel Spill-1 (FS-1) 2010 annual data presentation and plume boundary update that were based on data collected for the FS-1 System Performance and Ecological Impact Monitoring (SPEIM) program between October 2009 and December 2010. In addition, the data presentation included the results of a data gap investigation completed at FS-1 in 2010 and proposed an optimization of the FS-1 extraction, treatment, and discharge (ETD) system. The data presented includes results from the following sampling events:</p> <ul style="list-style-type: none"> • Biennial sampling of 10 monitoring wells (June-10) • Annual sampling of 33 monitoring wells (June-10) • Semiannual sampling of 3 extraction wells (Dec-09/June-10/Dec-10) • Monthly treatment plant sampling (Oct-09 through Dec-10) • Seasonal surface water sampling at Quashnet Bog (May, July, and Sep-10) <p>These data were presented to the regulatory agencies during the 16 March 2011 Technical Update Meeting. The handouts for the presentation included seven figures and presentation text slides. The data presentation is included as Attachment A.</p>	
<p>2.0 BACKGROUND</p> <p>The FS-1 plume is detached from its source area and is defined as the extent of groundwater contaminated with the contaminant of concern (COC), ethylene dibromide (EDB), at concentrations exceeding the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter ($\mu\text{g}/\text{L}$). The FS-1 EDB plume is being remediated through the operation of the FS-1 ETD system, which currently extracts contaminated groundwater via three extraction wells at a combined pumping rate of 515 gallons per minute.</p>	

Distribution: AFCEE: Jon Davis, Mike Minior, Rose Forbes, Bob Power, Admin. Record; EPA: Bob Lim; MassDEP: Len Pinnaud; Elliot Jacobs; Mashpee Consv: Drew McManus.; Haley & Aldrich: Bill Fisher; CH2M HILL: Pat de Groot, Nigel Tindall, Mark Hilyard, Doc. Control



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ITEM	REMARKS
	<p>Analytical data for the FS-1 plume have been collected through the SPEIM program since startup of the ETD system in 1999. This program was developed to monitor plume changes and to ensure the effective operation of the AFCEE groundwater remediation systems at the MMR; monitoring networks are also evaluated and optimized through the SPEIM program. The current approved FS-1 SPEIM monitoring network, including analytical scope and methods, is presented in the <i>Comprehensive Long Term Monitoring Plan</i>, which is available on-line at www.mmr.org under Plans and Protocols.</p>
3.0	<p>RESULTS</p> <p>Analytical results and concentration trend graphs were presented for select wells that are monitored throughout the FS-1 plume (Attachment A). Cross-sectional representations of the FS-1 plume, an updated FS-1 plume boundary, and EDB trends in groundwater and surface water were updated using the most recent data. An overview of the ETD system performance for the reporting period was also presented by providing treatment plant influent concentration trends, EDB mass removal, volume of groundwater treated, frequency of carbon exchanges, extraction well operational rates, and air emissions associated with the operation of the system.</p> <p>The data collected under the SPEIM program indicate that the remedial goals for the FS-1 ETD system are being met and that the extent of the plume, particularly south of 36EW0011 has continued to decrease. No EDB was detected in samples collected from monitoring wells located south of Grafton Pocknet Road (Figure 2 of Attachment A). The influent concentrations at the southernmost extraction well (36EW0001) have been sub-MMCL since 2008, most likely due to a decrease in plume extent and lower EDB concentrations in the vicinity of this well. This reduction in plume extent and concentration has likely resulted in the capture of more clean water by this extraction well indicating that the ETD system, and this well in particular, should be evaluated for optimization.</p> <p>Groundwater vertical profiling was conducted at FS-1 in 2010 to better define the extent of the EDB plume south of Grafton Pocknet Road. These data were collected to verify or update the conceptual site model and to support the optimization evaluation for the FS-1 ETD system. The results of groundwater vertical profiling at three locations at the FS-1 plume (Tables 1a and 1b and Figures 3 and 4 of Attachment A) are consistent with the recent data collected under the SPEIM program and confirm that the extent of the FS-1 plume, especially downgradient (i.e., south) of 36EW0011, has decreased significantly since system startup due to the operation of the ETD system and through the processes of natural attenuation. Groundwater vertical profiling results at borings advanced near 36EW0001 (36MW1045A and 36MW1046A) indicate that the extent of the plume in this area is now very limited and any remaining residual EDB detections are deep within the aquifer (>150 feet below ground surface [ft bgs]) as illustrated in Figures 5 and 6 of Attachment A. No EDB was detected at 35MW1046A and sub-MMCL concentrations of EDB was detected at two intervals at 36MW1045A (0.011 µg/L at 160-160 ft bgs and 0.014 µg/L at 180-185 ft bgs).</p>



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ITEM	REMARKS
	<p>The FS-1 groundwater model was used to simulate the fate and transport of this small area of EDB contamination located near 36EW0001 under a scenario where the extraction well 36EW0001 is turned off and 36EW0005 and 36EW0011 continue to operate at their current flow rates of 175 gpm, and 250 gpm, respectively. In addition, the groundwater model was used to assess any significant changes to the extent of the hydraulic capture at extraction wells 36EW0005 and 36EW0011 when 36EW0001 is turned off. Transport simulations predict that the EDB contamination in the vicinity of 36EW0001 attenuates to sub-MMCL concentrations by 2012. In addition, the modeling results suggest that there is no appreciable change to the extent of the hydraulic capture zones of 36EW0005 and 36EW0011 when 36EW0001 is turned off. Therefore, the remedial performance of these two wells would be unaltered under a scenario where 36EW0001 is shutdown.</p>
4.0	<p>CONCLUSIONS/RECOMMENDATIONS</p> <ul style="list-style-type: none">Groundwater EDB concentrations continue to decrease throughout the FS-1 plume monitoring network.The FS-1 plume continues to contract in the aquifer towards the operating extraction wells.Data collected during the 2010 data gap investigation confirm that the size and extent of the FS-1 plume has decreased south of 36EW0011 (South of Grafton Pocknet Road).Additionally the observed reduction in plume volume and/or EDB concentrations appears to be greatest in the vicinity of 36EW0001. Only two sub-MMCL detections of EDB were reported at the groundwater vertical profile locations advanced near 36EW0001 and no EDB was detected in monitoring wells located immediately downgradient or cross-gradient of this extraction well.The reduced volume of the plume near 36EW0001, as indicated by lack of EDB detections in nearby monitoring wells and groundwater vertical profiling locations indicate that this extraction well is no longer contributing to the remediation of the plume.The proposed plume boundary change, as shown on Figure 7 of Attachment A does not affect the current Private Well Land Use Control (LUC) boundary for FS-1.During the 16 March 2011 data presentation, it was recommended that:<ul style="list-style-type: none">The FS-1 EDB plume boundary should be updated as depicted in the data presentation (Attachment A, Figure 7).The FS-1 ETD system should be optimized by turning off 36EW0001. Based on modeling, the fate of the remaining EDB near 36EW0001 is predicted to



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ITEM	REMARKS
	<p>attenuate to sub-MMCL concentrations by 2012 and remain deep in the aquifer. The attenuation of this small area of EDB contamination can be adequately monitored through a proposed increase of sampling frequency at monitoring wells located immediately downgradient and cross-gradient of the small area of EDB mass (monitoring well clusters 36MW1012A,B,C; 36MW1045A,B; and 36MW0132A,B,C) (Figure 8, Attachment A).</p>
5.0	<p>REGULATOR COMMENTS/ACTION ITEMS</p> <p>During the 16 March Technical Update Meeting, the Massachusetts Department of Environmental Protection (MassDEP) commented that although the extent of the EDB plume is likely very limited in the vicinity of 36EW0001, detectable concentrations of EDB are still reported in the influent at this extraction well (0.017 µg/L in December 2009 – 0.011 µg/L in December 2010). However, this well likely extracts a large volume of clean water from the aquifer over its 60-foot long extraction screen due to the collapse of the EDB plume over the past several years. Therefore, based on the detectable levels of EDB in the influent at extraction well 36EW0001, it is possible that EDB remains at concentrations at or greater than the MMCL of 0.02 µg/L near 36EW0001. Based on this observation, MassDEP requested that additional sampling be completed at 36EW0001 to help determine whether this extraction well should continue to operate; AFCEE concurred with MassDEP's request. The proposed sampling consists of first installing a packer at 36EW0001 so that groundwater is extracted from the bottom 15 feet of well screen; then influent sampling and flow testing will be completed to provide additional data to assess whether EDB is present near 36EW0001 at concentrations above the MMCL. The results of this additional testing will be shared with the regulatory agencies and a path forward regarding the optimization of 36EW0001 will be formulated through the technical update meeting progress.</p> <p>A check-in with regulatory agencies was made at the 11 May 2011 Technical Update Meeting and no additional comments regarding the proposed FS-1 plume boundary or other conclusions resulting from the annual data presentation were received. The installation of the packer at 36EW0001 was pending as of the 11 May Technical Update Meeting. Therefore this project note serves only to document the regulatory concurrence with the new plume boundary at FS-1 as well as the path forward for additional optimization sampling at 36EW0001. No changes to the FS-1 monitoring network will be made at this time. The results of the optimization sampling at 36EW0001 and the path forward for the optimization of this well will be documented in a future project note.</p>

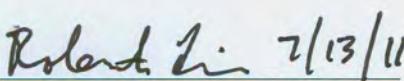
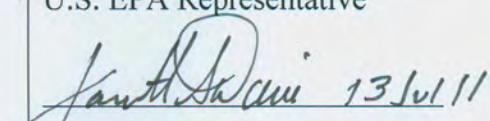
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ITEM	REMARKS
6.0	<p>CONCURRENCE</p> <p>Concurrence with the updated FS-1 plume boundary presented during the FS-1 2010 SPEIM annual data presentation (Attachment A) is represented by the signatures below:</p> <p> 7/13/11 U.S. EPA Representative</p> <p> 7/13/2011 MassDEP Representative</p> <p> 13 Jul 11 AFCEE Project Manager</p> <p>Note: The parties involved will retain the ability to modify the FS-1 plume boundary based on field observations or other mutually agreeable technical justifications.</p>

Attachment:

Attachment A: FS-1 2010 Annual SPEIM Data Presentation and ETD System Optimization, 16 March 2011 Technical Update Meeting

ATTACHMENT A

FS-1 2010 Annual SPEIM Data Presentation and ETD System Optimization

16 March 2011 Technical Update Meeting

Presentation Overview

- SPEIM Results
- Data Gap Investigation results (plan presented during 2009 Annual Update, field work completed in December 2010)
- ETD system optimization

FS-1 2010 Annual SPEIM Data Presentation

SPEIM Overview

- Sampling dates: Oct-09 through Dec-10
- Sampling locations and plume boundary (Figure 1):
 - Biennial sampling of 10 monitoring wells (June-10)
 - Annual sampling of 33 monitoring wells (June -10)
 - Semiannual sampling of 3 extraction wells (Dec-09/June-10/Dec-10)
 - Monthly sampling of treatment plant influent (Oct-09 through Dec-10)
 - Surface water sampling at Quashnet Bog (May, July and Sep-10)
- Trend analysis
 - Comparison of current data to previous result for each location
 - Trend plots for key monitoring wells

FS-1 2010 Annual SPEIM Data Presentation

SPEIM Overview (continued)

- Remedial system performance
- Data gap results (groundwater vertical profiling for EDB)
- FS-1 CSM review and plume boundary update

FS-1 2010 Annual SPEIM Data Presentation

Highlights of Data Review (Figure 1)

- EDB concentrations north of 36EW0011
 - 36MW0503 cluster continue to decrease
 - “A” screen: 0.074 µg/L (down from 0.264 µg/L in 2008)
 - “B” screen: ND (down from BRL in 2008)
 - “C” screen: ND (down from BRL in 2008)
 - 36MW1039 cluster ND or decreasing:
 - “A” and “B” screens remain ND
 - 36MW1038 cluster remain ND
 - 36MW1040 cluster decreasing
 - “A” screen 0.029 µg/L (down from 0.047 µg/L in June-09).
 - “B” screen remains ND
 - 36MW1041 cluster ND or decreasing:
 - “A” screen 0.454 µg/L (down from 0.857 µg/L in June-09).
 - “B” and “C” screens remain ND

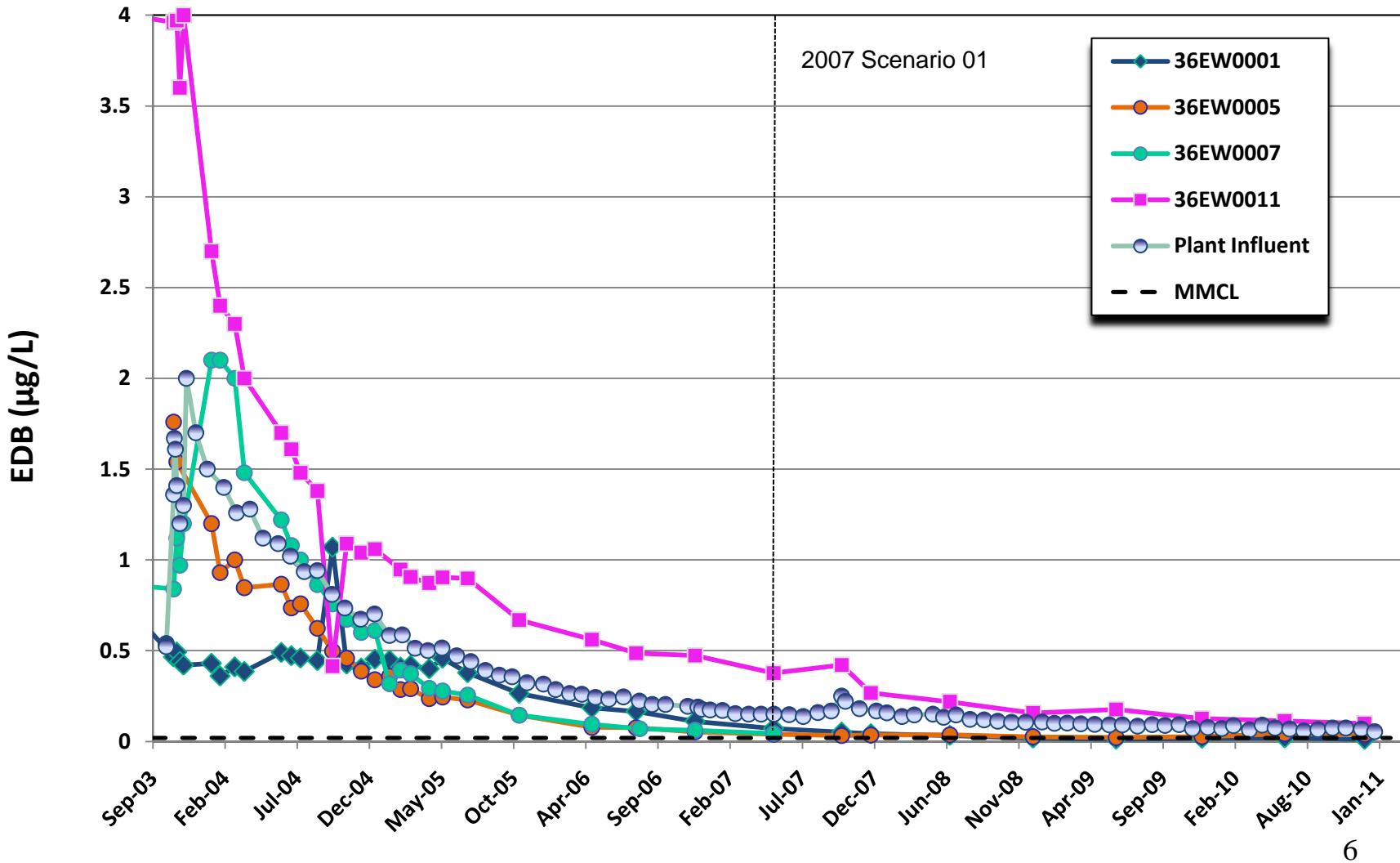
FS-1 2010 Annual SPEIM Data Presentation

Highlights of Data Review (cont)

- Concentrations south of Grafton Pocknet Road (Figure 2 –hits map)
 - No detects at existing groundwater monitoring locations, south of Grafton Pocknet Road
 - 36MW1010A,B, and C and 36PZ1010 remain ND.
 - 36MW1003A ND (Down from BRL in June-09); 36PZ1003 remains ND.
 - 36MW1014A,B remain ND.
 - 36EW4020 remains ND.
 - 36MW1012A,C remain ND; “B” screen ND (down from 0.016 µg/L in June-09).
 - 36PZ1002 cluster remain ND.
 - 36MW0131B and C remain ND; “A” screen ND (down from BRL in June-09)
 - 36MW0132A,B, and C remain ND
 - 36MW0136 remains ND

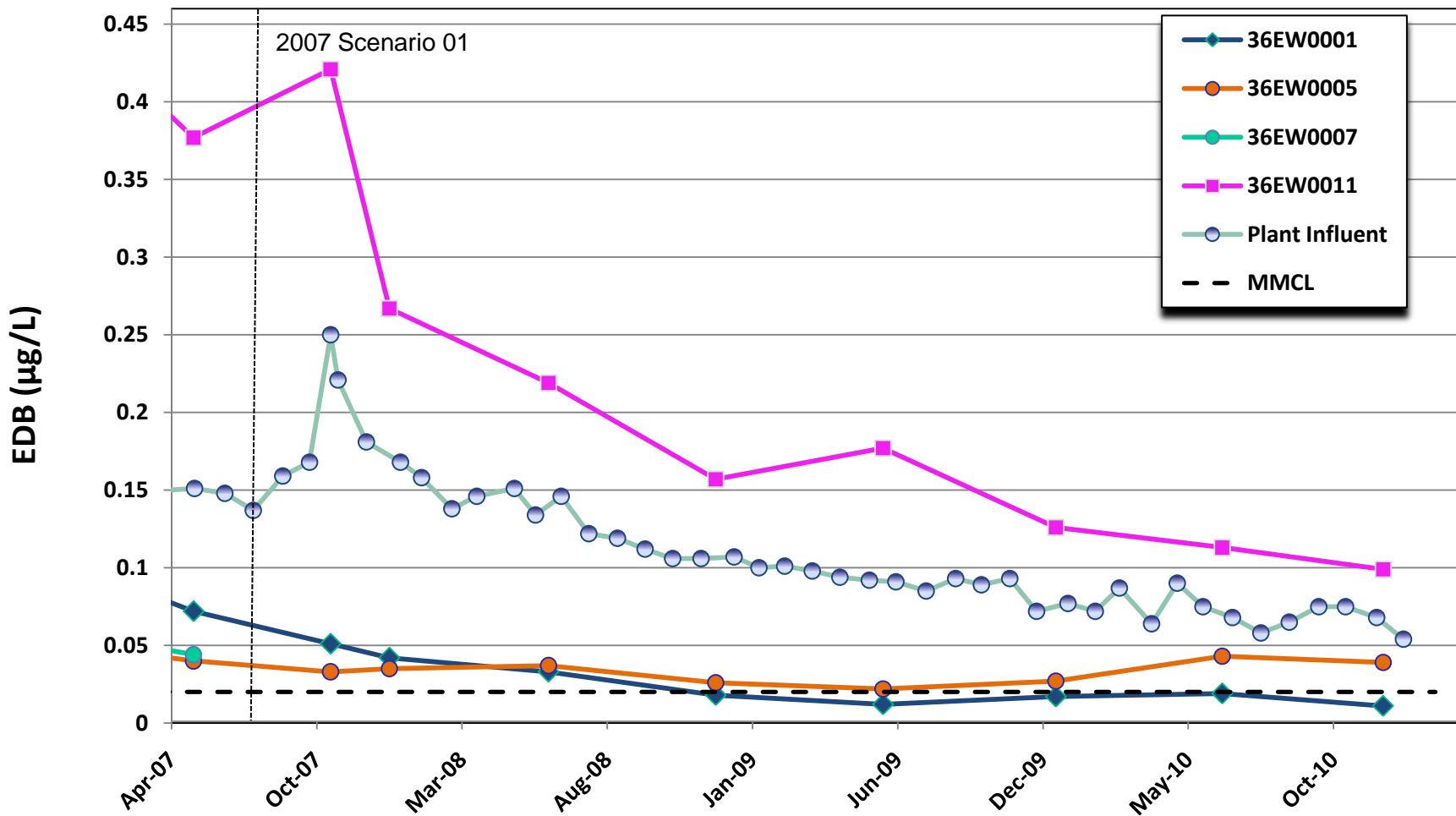
FS-1 2010 Annual SPEIM Data Presentation

FS-1 Extraction Well and Plant Influent Data (2003-present)



FS-1 2010 Annual SPEIM Data Presentation

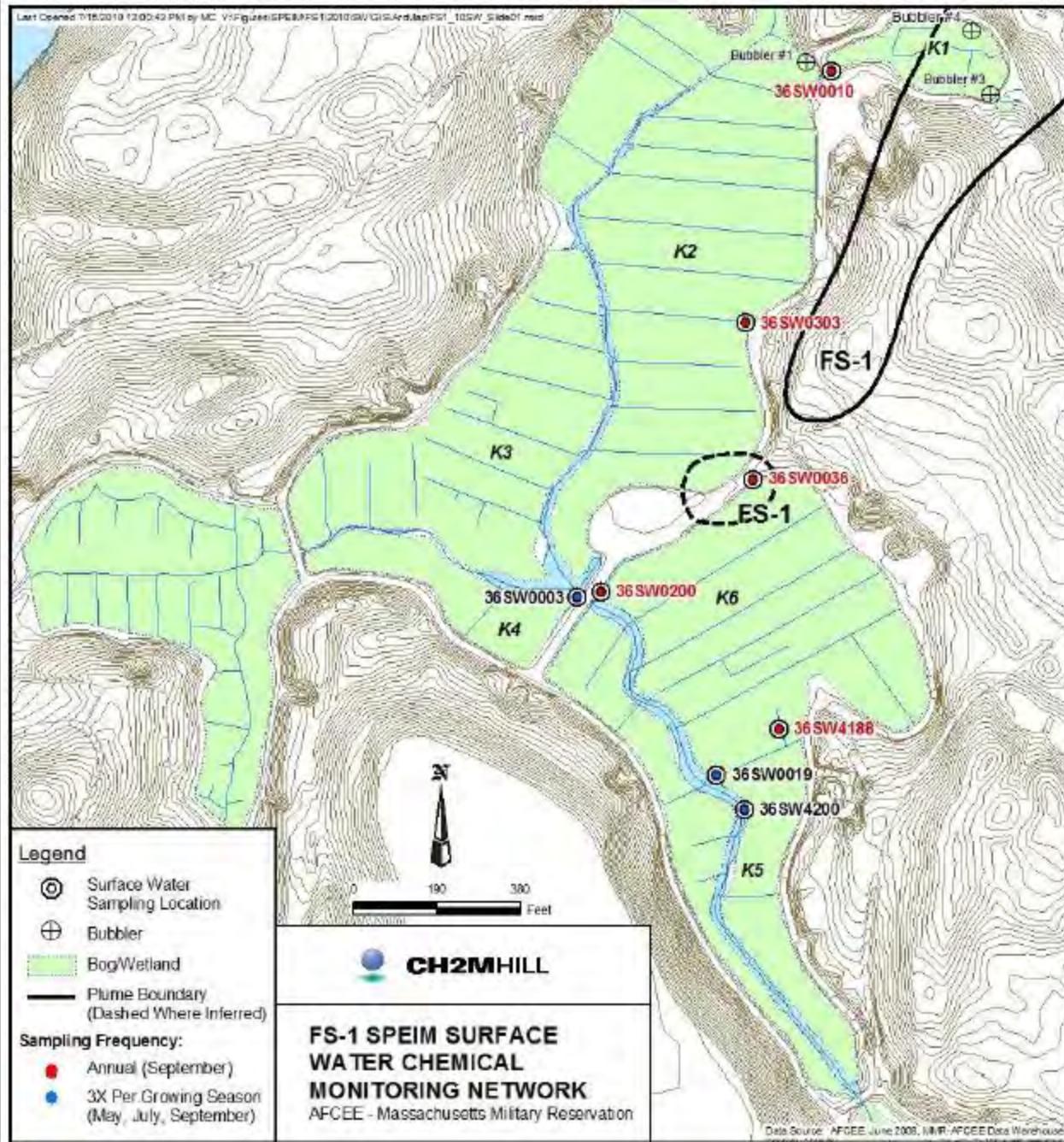
FS-1 Extraction Well and Plant Influent Data - 5 Year Overview



FS-1 2010 Annual SPEIM Data Presentation

ETR System Summary

- Approximately 329 million gallons of groundwater treated by ETR system (Oct-09 to Dec-10)
- 0.202 pounds of EDB removed; 17.76 pounds since system startup
- 2 carbon exchanges
- Extraction wells operated between 95%-99% design rates
- Electrical usage and related air emissions will be reported in the 2010 SLR



FS-1 Surface Water Results September 2010

EDB Concentrations (µg/L)

	<u>36SW0003</u>	<u>36SW0019</u>	<u>36SW4200</u>			
07/18/07	ND	07/18/07	0.013	07/18/07	0.022	
09/17/07	ND	09/17/07	ND	09/17/07	0.013	
05/20/08	ND	05/20/08	ND	05/20/08	ND	
07/15/08	ND	07/15/08	BRL	07/15/08	ND	
09/09/08	ND	09/09/08	BRL	09/09/08	ND	
05/19/09	ND	05/19/09	ND	05/19/09	ND	
07/07/09	ND	07/07/09	BRL	07/07/09	ND	
09/08/09	ND	09/08/09	0.023	09/08/09	0.011	
05/24/10	ND	05/24/10	ND	05/24/10	ND	
07/20/10	ND	07/20/10	0.019	07/20/10	0.025	
09/09/10	ND	09/09/10	0.015	09/09/10	BRL	
	<u>36SW0010</u>	<u>36SW0036</u>	<u>36SW0200</u>			
07/18/07	NS	07/18/07	NS	07/18/07	NS	
09/17/07	ND	09/17/07	ND	09/17/07	ND	
05/20/08	NS	05/20/08	NS	05/20/08	NS	
07/15/08	NS	07/15/08	NS	07/15/08	NS	
09/09/08	ND	09/09/08	ND	09/09/08	ND	
05/19/09	NS	05/19/09	NS	05/19/09	NS	
07/07/09	NS	07/07/09	NS	07/07/09	NS	
09/08/09	ND	09/08/09	ND	09/08/09	ND	
05/24/10	NS	05/24/10	NS	05/24/10	NS	
07/20/10	NS	07/20/10	NS	07/20/10	NS	
09/09/10	ND	09/09/10	ND	09/09/10	ND	
	<u>36SW0303</u>	<u>36SW4186</u>				
07/18/07	NS	07/18/07	NS			
09/17/07	ND	09/17/07	ND			
05/20/08	NS	05/20/08	NS			
07/15/08	NS	07/15/08	NS			
09/09/08	ND	09/09/08	ND			
05/19/09	NS	05/19/09	NS			
07/07/09	NS	07/07/09	NS			
09/08/09	ND	09/08/09	ND			
05/24/10	NS	05/24/10	NS			
07/20/10	NS	07/20/10	NS			
09/09/10	ND	09/09/10	ND			

ND = Not Detected, NS = Not Sampled

BRL = below reporting limit

FS-1 2010 Annual SPEIM Data Presentation

Field Data Gap Investigation (Figure 3)

- SPEIM monitoring indicated there was an opportunity to optimize 36EW0001
- Needed to better characterize EDB mass south of Grafton Pocknet Road
- Groundwater vertical profiling attempted with direct push rig at three locations in May 2010; met with shallow refusal at all 3 locations (results presented at 23 June 2010 Technical Update Meeting)
- 2 locations near 36EW0001 were completed to bedrock in December 2010 using sonic drilling techniques (36MW1045A and 36MW1046A; Tables 1a and 1b)

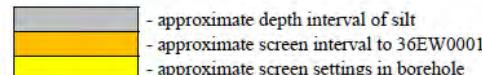
FS-1 2010 Annual SPEIM Data Presentation

Sonic Drilling Update- 36MW1045A

Table 1a
Borehole Groundwater Screening Results
FS-1 Direct Push and Sonic Location
36DP0101 and 36MW1045A

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02 µg/L
A	5/18/2010	25	30	27.5	30.5	ND
B	5/18/2010	35	40	37.5	20.5	ND
C	5/18/2010	45	50	47.5	10.5	ND
D	5/18/2010	55	60	57.5	0.5	ND
E	5/18/2010	65	70	67.5	-9.5	ND
F	5/18/2010	75	80	77.5	-19.5	ND
G	5/19/2010	85	90	87.5	-29.5	ND
H	5/19/2010	95	100	97.5	-39.5	NS
I	5/19/2010	105	110	107.5	-49.5	ND
A	12/5/2010	110	115	112.5	-54.5	ND
B	12/5/2010	120	125	122.5	-64.5	ND
C	12/6/2010	130	135	132.5	-74.5	ND
D	12/6/2010	140	145	142.5	-84.5	ND
E	12/6/2010	150	155	152.5	-94.5	NS
F	12/6/2010	160	165	162.5	-104.5	0.011
G	12/6/2010	170	175	172.5	-114.5	ND
H	12/6/2010	180	185	182.5	-124.5	0.014
I	12/7/2010	190	195	192.5	-134.5	ND
J	12/7/2010	200	205	202.5	-144.5	NS
K	12/7/2010	210	215	212.5	-154.5	NS
L	12/7/2010	220	225	222.5	-164.5	ND
M	12/7/2010	230	235	232.5	-174.5	ND
N	12/7/2010	240	245	242.5	-184.5	NS
O	12/7/2019	250	255	252.5	-194.5	NS
P	12/7/2019	260	265	262.5	-204.5	NS

Data Source: AFCEE-MMR Data warehouse



Key:

BOS = bottom of sample
 BRL = below reporting limit
 EDB = ethylene dibromide
 ft bgs = feet below ground surface
 ft msl = feet mean sea level

MMCL = Massachusetts Maximum Contaminant Level
 ND = not detected
 NS = no sample collected
 TOS = top of sample
 µg/L = micrograms per liter

Notes:

Approximate elevation of ground surface is 58 ft msl.
 Bedrock encountered at 267 ft bgs
 Monitoring wells were installed at 180-185 ft bgs (A screen) and 115-120 ft bgs (B screen)

FS-1 2010 Annual SPEIM Data Presentation

Sonic Drilling Update – 36MW1046A

Table 1b
Borehole Groundwater Screening Results
FS-1 Direct Push and Sonic Locations
36DP0102 and 36MW1046A

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02 µg/L
A	5/21/2010	25	30	27.5	29.5	ND
B	5/21/2010	35	40	37.5	19.5	ND
C	5/21/2010	45	50	47.5	9.5	ND
D	5/21/2010	55	60	57.5	-0.5	ND
E	5/25/2010	65	70	67.5	-10.5	ND
F	5/25/2010	75	80	77.5	-20.5	ND
G	5/25/2010	85	90	87.5	-30.5	ND
H	5/25/2010	93	98	95.5	-38.5	ND
I	5/26/2010	105	110	107.5	-50.5	ND
J	5/26/2010	110	115	112.5	-55.5	ND
A	12/10/2010	110	115	112.5	-55.5	ND
B	12/10/2010	120	125	122.5	-65.5	ND
C	12/10/2010	130	135	132.5	-75.5	ND
D	12/10/2010	140	145	142.5	-85.5	ND
E	12/10/2010	150	155	152.5	-95.5	ND
F	12/10/2010	160	165	162.5	-105.5	ND
G	12/13/2010	170	175	172.5	-115.5	ND
H	12/13/2010	180	185	182.5	-125.5	ND
I	12/13/2010	190	195	192.5	-135.5	ND
J	12/13/2010	200	205	202.5	-145.5	NS
K	12/14/2010	210	215	212.5	-155.5	NS
L	12/14/2010	220	225	222.5	-165.5	ND
M	12/14/2010	230	235	232.5	-175.5	NS
N	12/14/2010	240	245	242.5	-185.5	NS
O	12/14/2010	250	255	252.5	-195.5	NS
P	12/14/2010	260	265	262.5	-205.5	NS

Data Source: AFCEE-MMR Data warehouse

 - approximate depth interval of silt

Key:

BOS = bottom of sample
 BRL = below reporting limit
 EDB = ethylene dibromide
 ft bgs = feet below ground surface
 ft msl = feet mean sea level

MMCL = Massachusetts Maximum Contaminant Level
 ND = not detected
 NS = no sample collected
 TOS = top of sample
 µg/L = micrograms per liter

Notes:

Approximate elevation of ground surface is 57 ft msl.
 Bedrock encountered at 267 ft bgs
 No monitoring wells were installed at this location.

FS-1 2010 Annual SPEIM Data Presentation

Findings -Field Data Gap Investigation (Figure 3)

- No EDB plume between 36EW0001 and 36MW0136
- Remaining EDB in capture zone of 36EW0001 is likely to be low concentration, very limited in extent.
- EDB detects in surface water at Quashnet Bog are isolated from main plume.

FS-1 2010 Annual SPEIM Data Presentation

FS-1 CSM and Boundary Update

- Cross-Section A-A' (Figure 4)
 - Most plume mass is upgradient of 36EW0011
 - Plume volume has decreased downgradient of 36EW0011
- Cross-Section B-B' (Figure 5)
 - Plume not present between 36EW0001 and 36MW0136
 - Remaining EDB in 36EW0001 capture zone likely near bottom of EW screen
- EDB Concentration Trends and Revised Plume Boundary (Figure 6)
 - EDB concentration trends are decreasing throughout plume.
 - Volume of plume south of 36EW0011 has been significantly reduced
 - EDB within capture zone of 36EW0001 likely low concentration and limited in extent.
- EDB detections in surface water continue to be intermittent, related to remnants of the uncaptured portion of the plume beneath the bogs.
- 36EW0001 should be optimized

FS-1 ETD System Optimization

- SPEIM monitoring data and groundwater vertical profile results indicate that mass and volume of EDB remaining within the capture zone to 36EW0001 is very low and limited in extent.
 - Influent has been sub-MMCL since December 2008.
 - No detections of EDB at monitoring wells located with capture zone to 36EW0001.
 - Sub-MMCL EDB concentrations reported in only 2 intervals at a groundwater vertical profile (36MW1045A) advanced approximately 85 feet cross-gradient to the well
- Detections of EDB in surface water are the result of residual EDB that is outside the influence of the ETD system and is isolated from the FS-1 plume.
- As a result, the operation of 36EW0001 is no longer contributing to the remediation of the plume.
- The existing groundwater model was used to predict the plume transport and extent of hydraulic capture with 36EW0001 turned off.

FS-1 ETD System Optimization

Groundwater Modeling Support and Analysis:

- Advanced the 2007 plume shell until the simulation matched the results of the most recent SPEIM groundwater data set. The 2013 time step of the transport simulation most closely matches the most recent SPEIM groundwater data set .
- The transport simulation was baselined by assigning the 2013.5 simulation time step as 2010. Then the groundwater model was used to simulate plume shell transport with 36EW0001 turned off in 2011 and 36EW0005 and 36EW0011 pumping at current flow rates (175 and 200 gpm, respectively)
- In addition, the groundwater model was used to evaluate impacts, if any, to the hydraulic capture zones of 36EW0005 and 36EW0011 with 36EW0001 turned off.

FS-1 ETD System Optimization

RESULTS

- Transport simulations predict that the EDB mass within the capture zone to 36EW0001 attenuates in the aquifer to sub-MMCL concentrations by 2012.
- No appreciable change to the capture zones of 36EW0005 and 36EW0011 with 36EW0001 turned off.

FS-1 ETD System Optimization

Conclusions – ETD Optimization

- ✓ Continuing to operate 36EW0001 will no longer contribute to remediation of the plume
- ✓ Extent of plume capture by 36EW0005 and 36EW0001 is unaffected by the shutdown of 36EW0001
- ✓ Mass removal efficiency of the ETD system is expected to increase when 36EW0001 is turned off
- ✓ Sufficient network is available to monitor groundwater immediately downgradient of 36EW0001 (Figure1)

FS-1 ETD System Optimization

Recommendations –SPEIM Data Presentation and ETD Optimization

- ✓ Update plume boundary as depicted in Figures 4,5 and 6
 - No changes to FS-1 LUC boundary or parcel count (Figure 7)
- ✓ Optimize the FS-1 ETD system by shutting down 36EW0001 and operating 36EW0005 and 36EW0011 at current flow rates (175 gpm, and 250 gpm respectively)
 - New pumping configuration will be called 2010 Scenario 01
- ✓ Increase frequency of sampling at 36MW0132A,B,C and 36MW1012A,B,C from annual to semiannual and add new monitoring wells 36MW1045A,B at a semiannual frequency (Figure 8).
- ✓ Conduct annual SPEIM sampling event in May 2011 and a semiannual event in December 2011 .
- ✓ Optimize FS-1 SPEIM network based on data collected through December 2011.

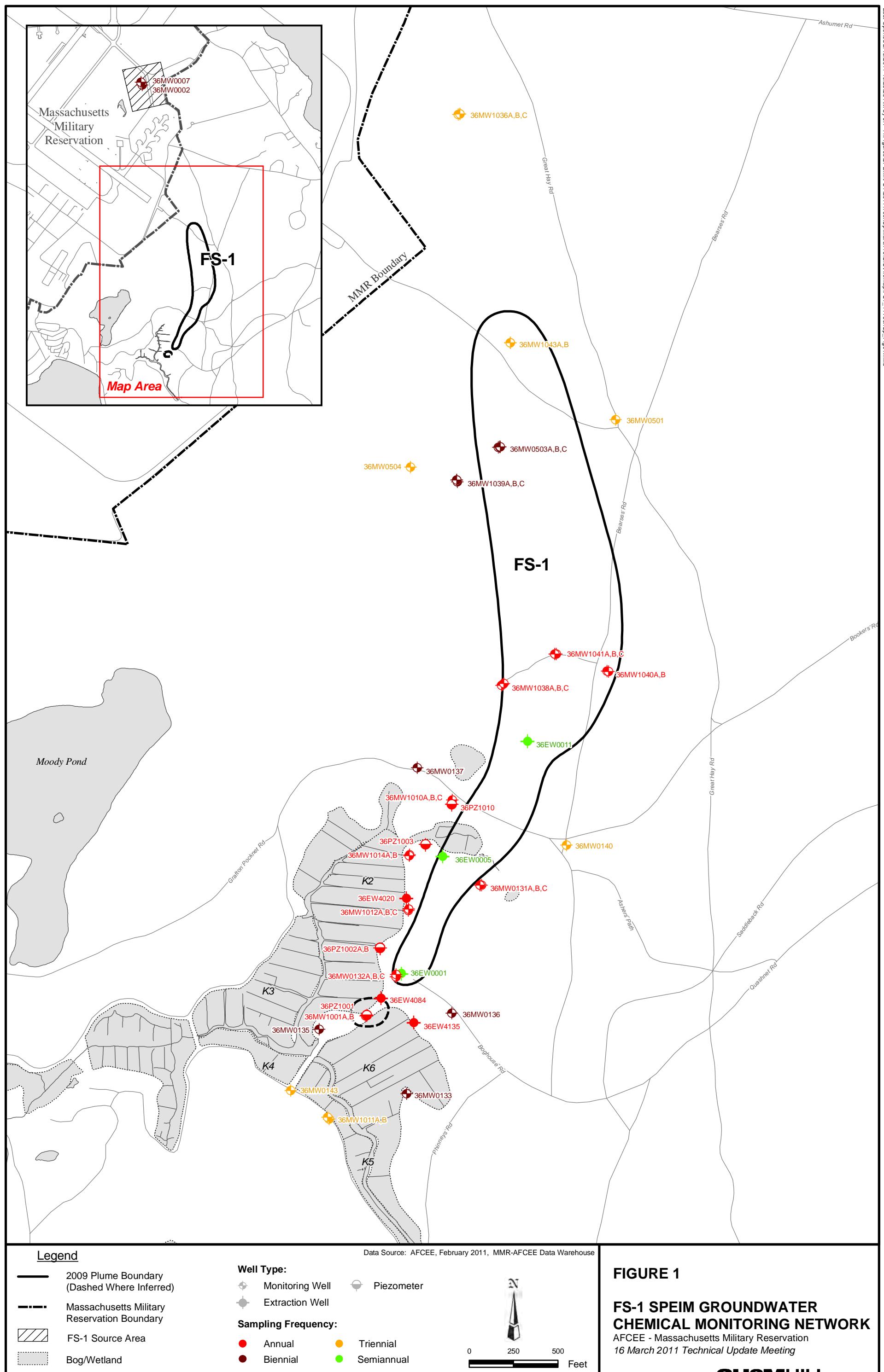
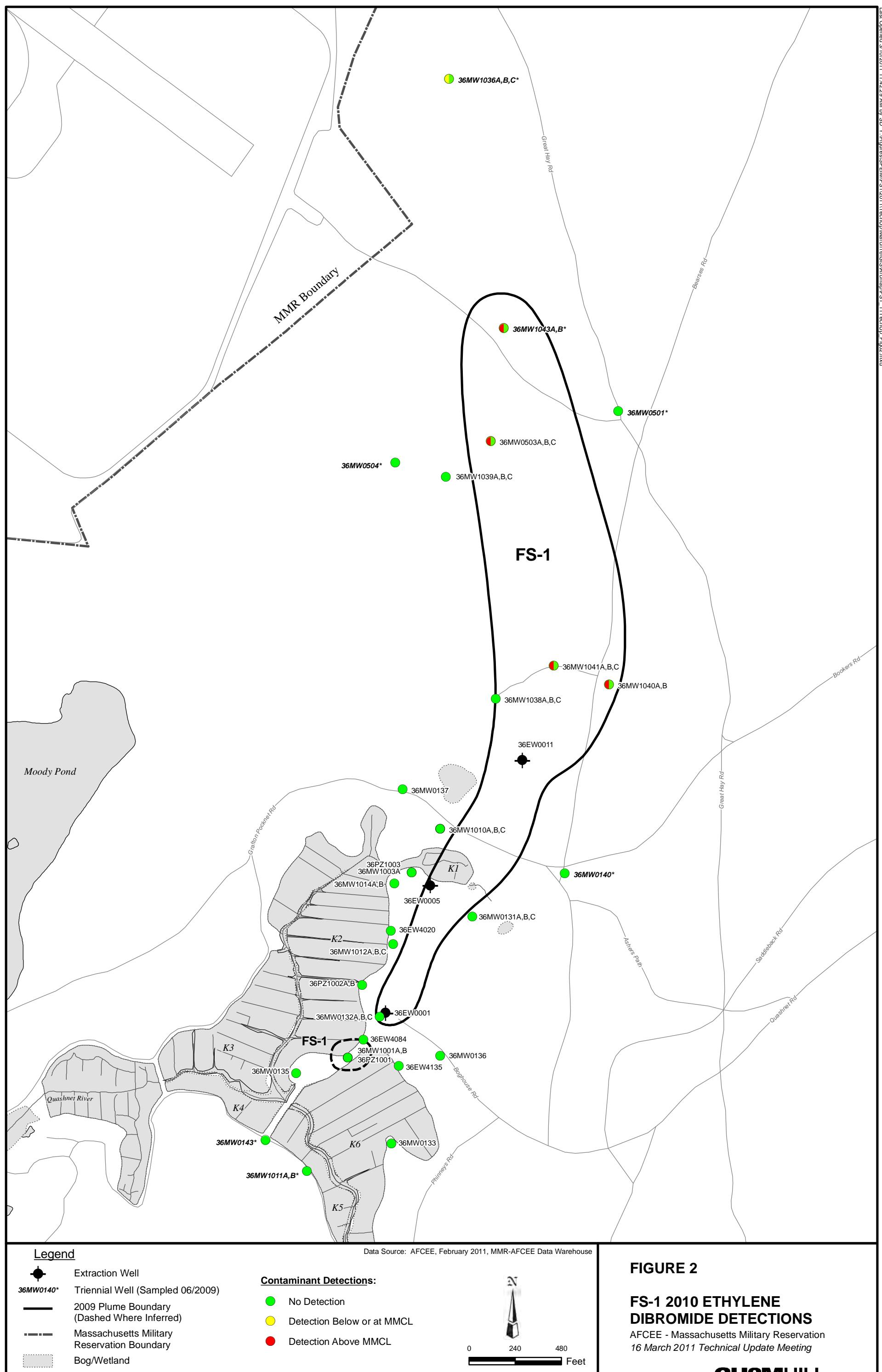
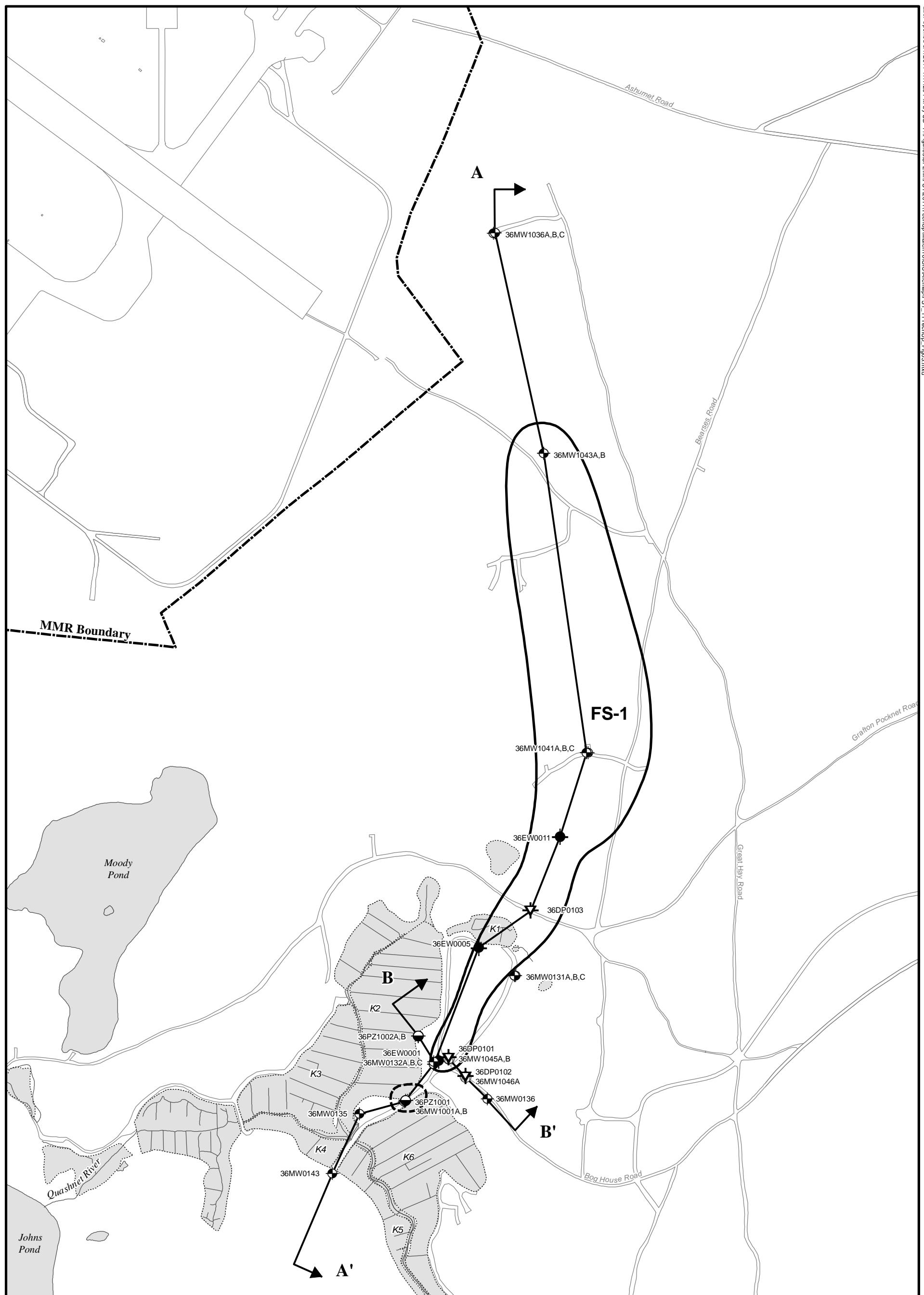


FIGURE 1

FS-1 SPEIM GROUNDWATER CHEMICAL MONITORING NETWORK

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16 March 2011 Technical Update Meeting





Legend

- Extraction Well
- Monitoring Well
- Piezometer
- ▼ Direct Push
- Sonic Locations
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Cross-Section Line
- Bog/Wetland

Data Source: AFCEE, February 2011, MMR-AFCEE Data Warehouse

N

0 290 580 Feet

FIGURE 3

FS-1 EDB PLUME AND LOCATION OF CROSS-SECTION LINES
AFCEE - Massachusetts Military Reservation
16 March 2011 Technical Update Meeting

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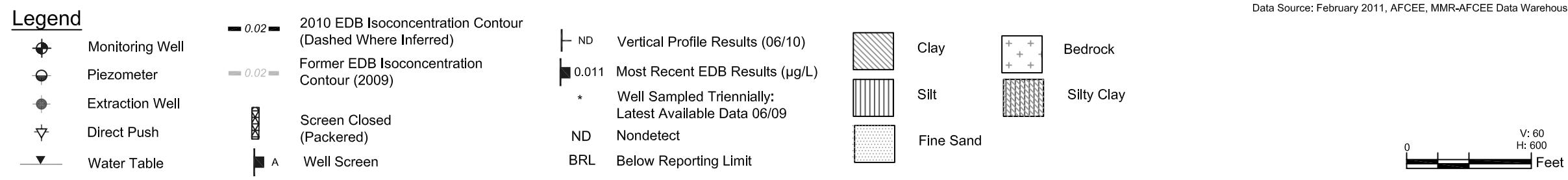
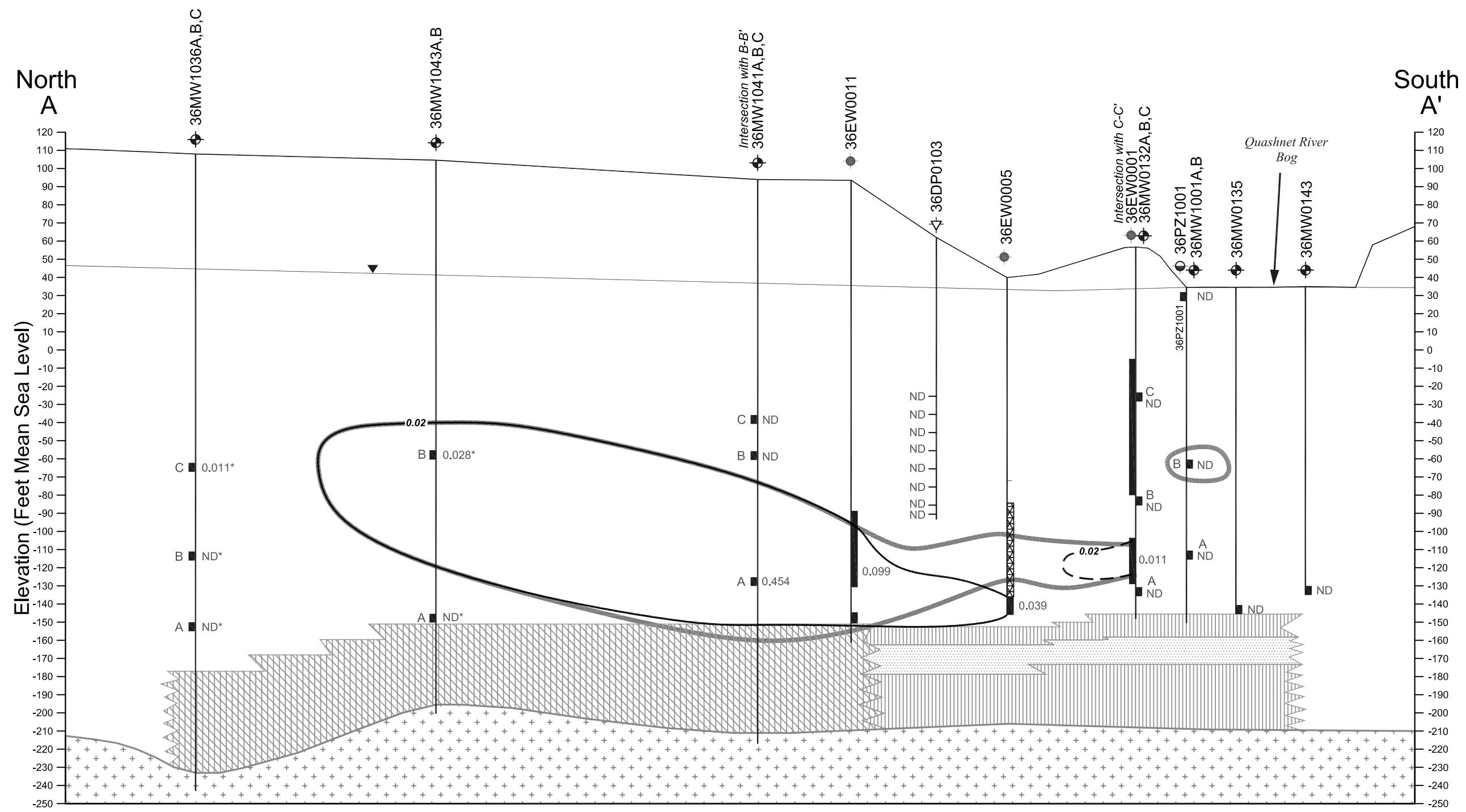
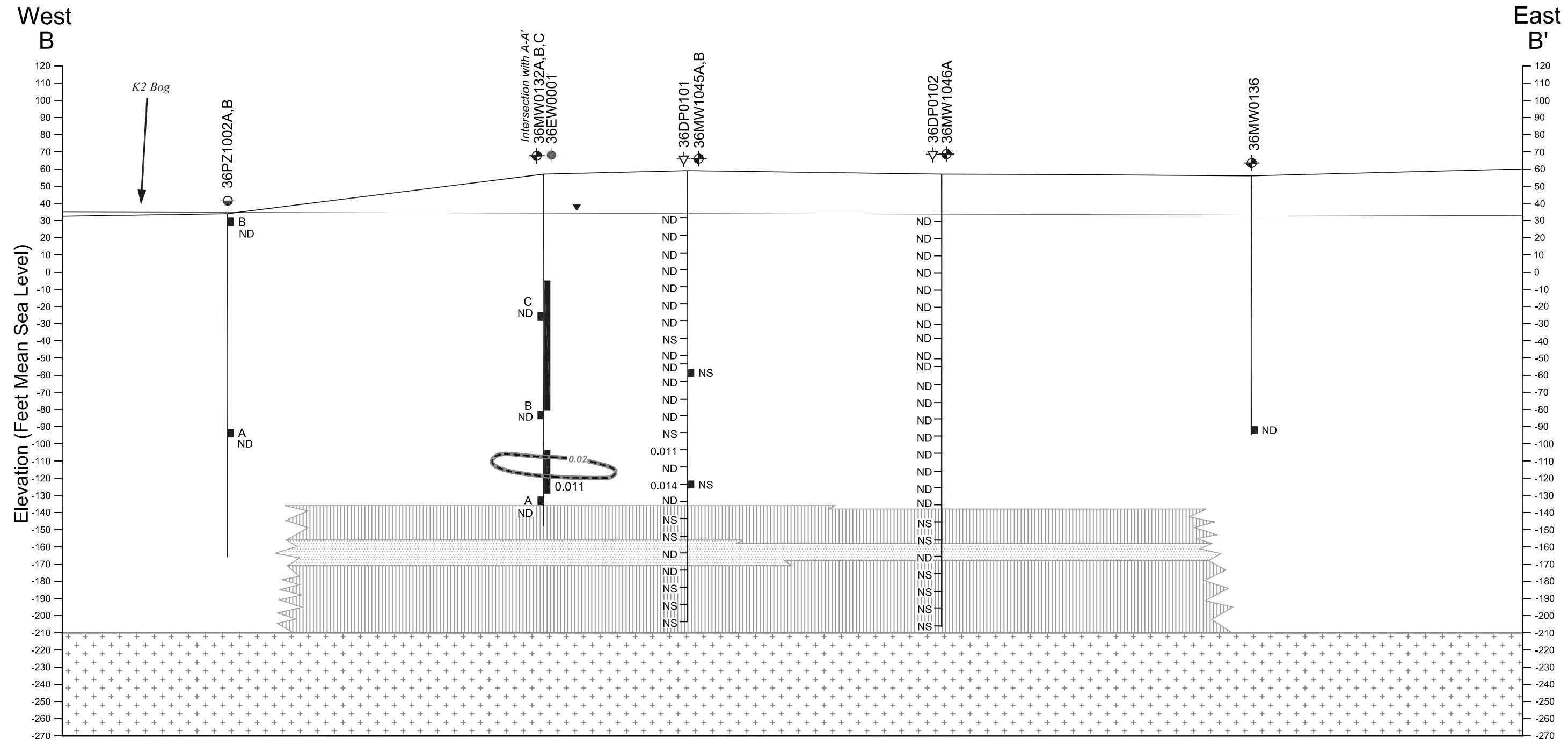


FIGURE 4

FS-1 CROSS-SECTION A-A'

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16 March 2011 Technical Update Meeting



Legend

- | | | | | | |
|---|-----------------|---|---|--|---------------------------------|
|  | Monitoring Well |  | 2010 EDB Isoconcentration Contour (Dashed Where Inferred) |  | Vertical Profile Results (2010) |
|  | Piezometer | | |  | Most Recent EDB Results (µg/L) |
|  | Extraction Well |  | Former EDB Isoconcentration Contour (2009) |  | Nondetect |
|  | Direct Push | | |  | Not Sampled |
|  | Water Table |  | Well Screen |  | |

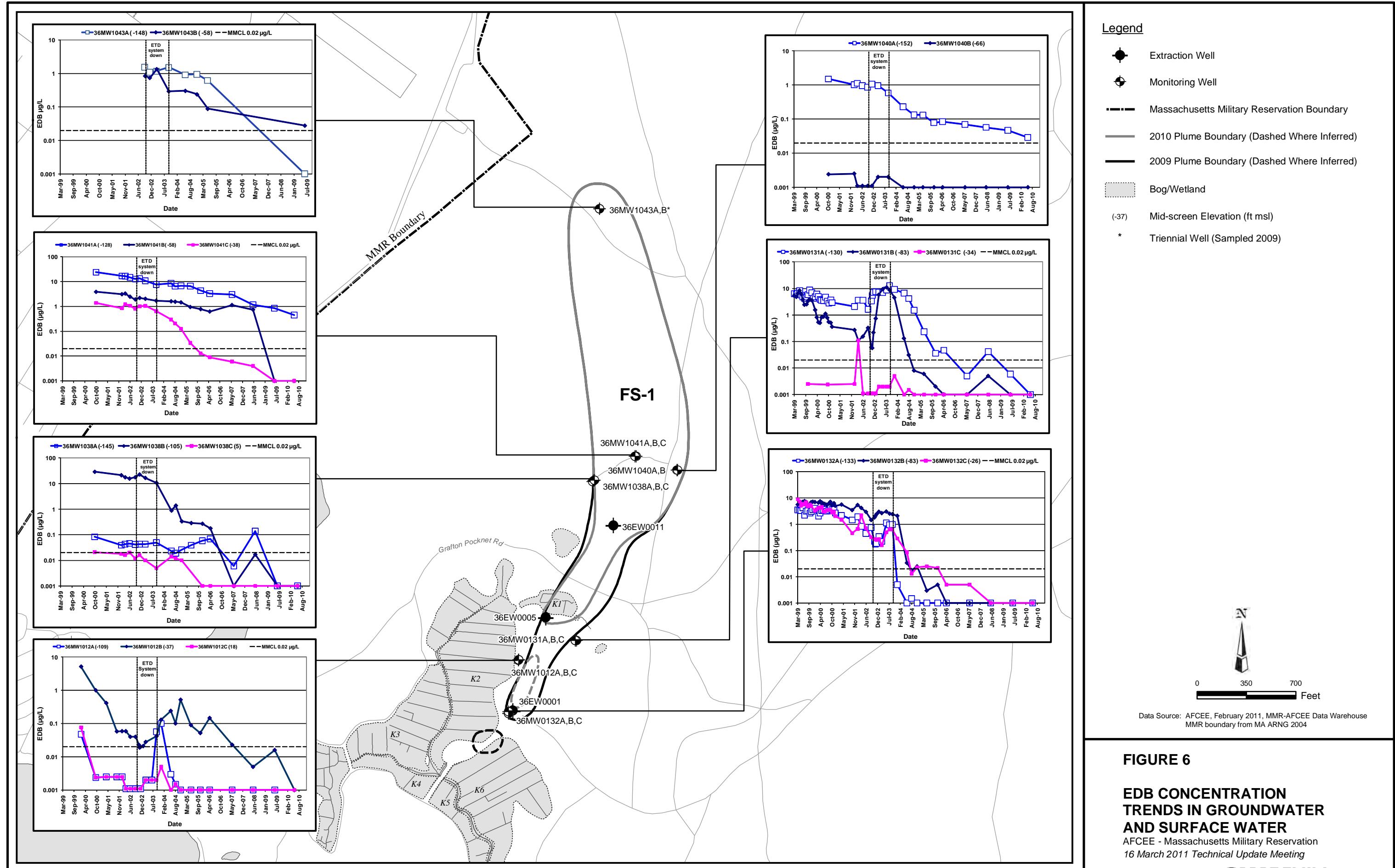
Data Source: February 2011, AFCEE, MMR-AFCEE Data Warehouse

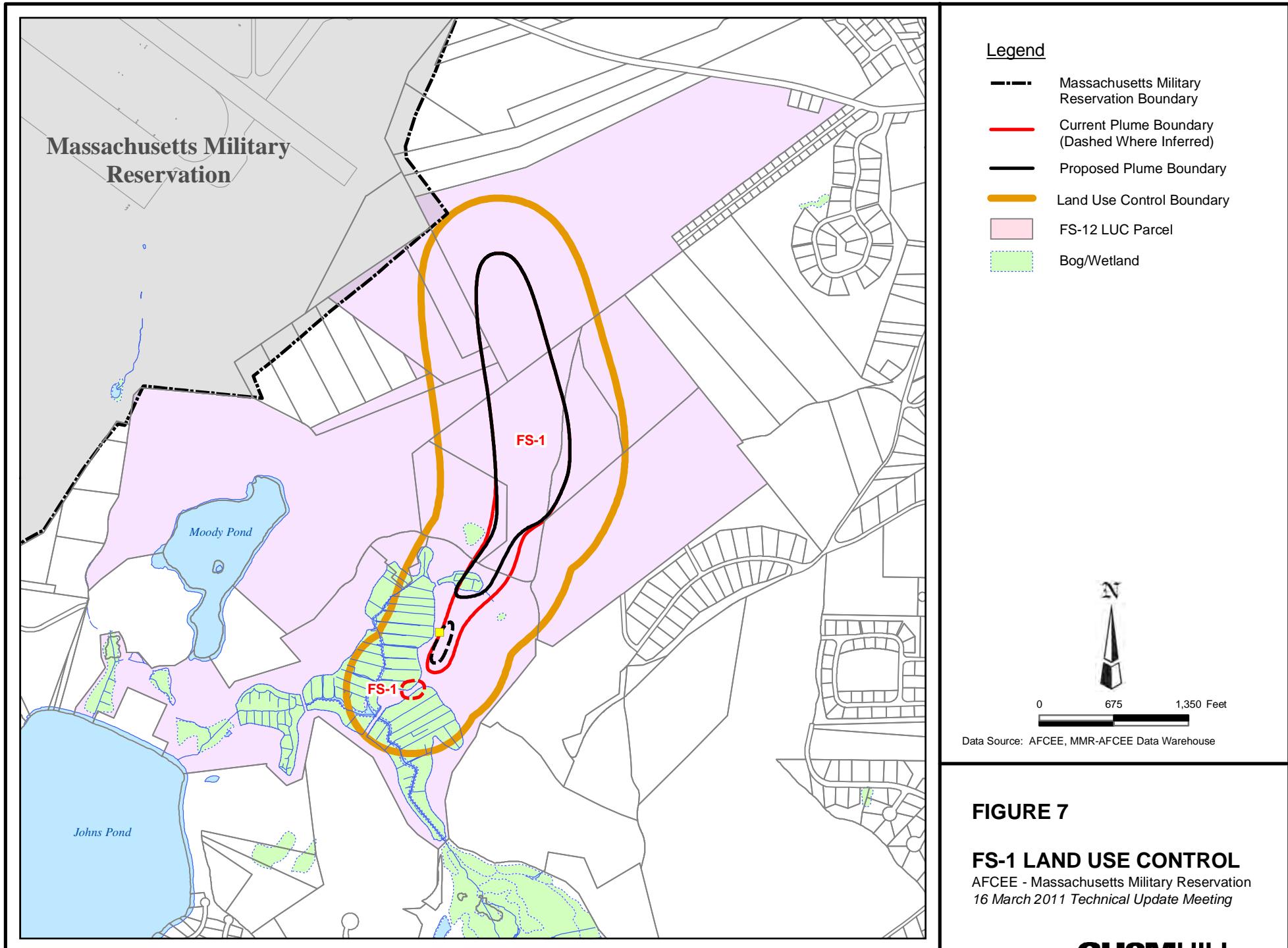
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FIGURE 5

FS-1 CROSS-SECTION B-B'

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16 March 2011 Technical Update Meeting





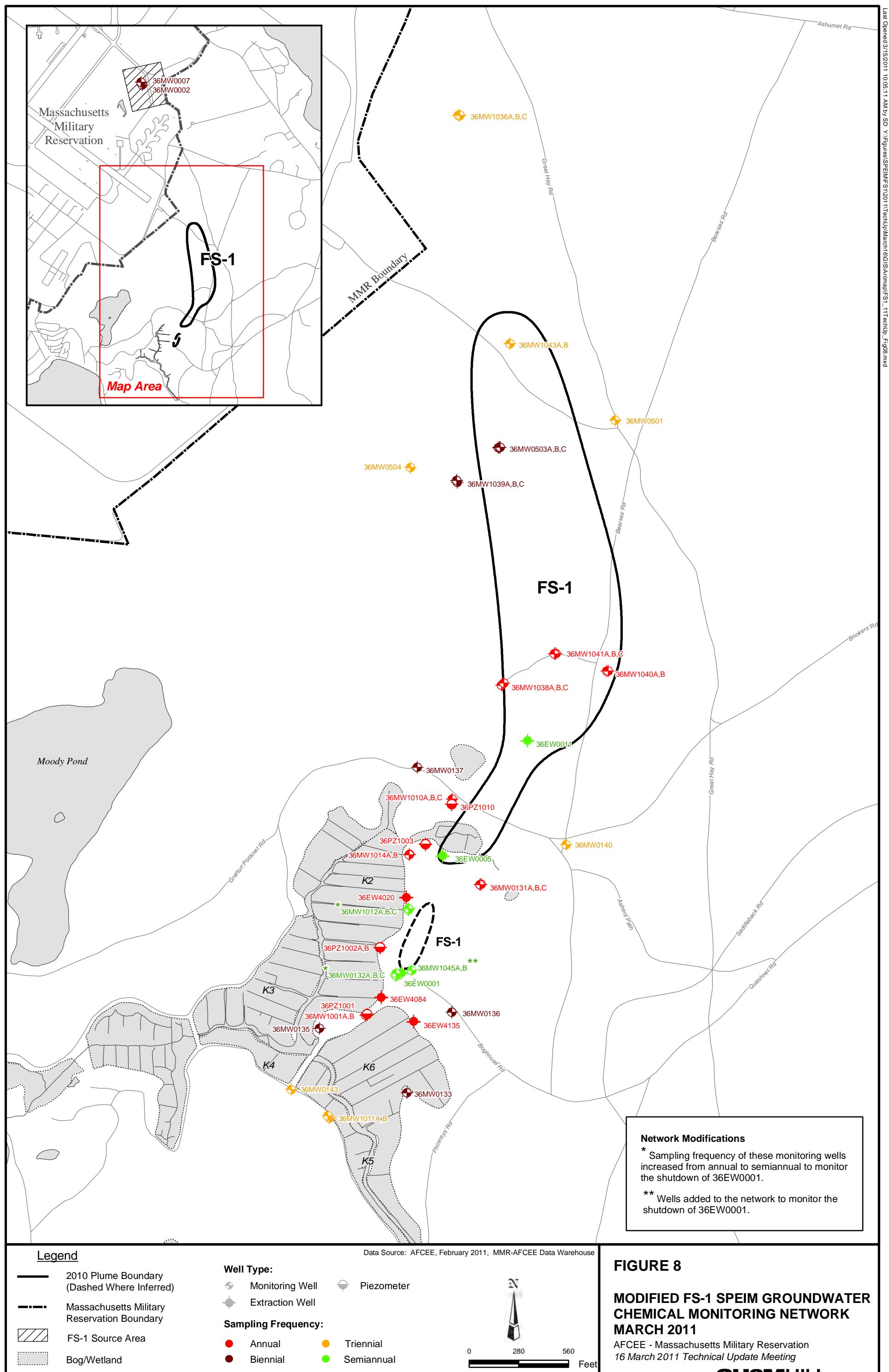


FIGURE 8

MODIFIED FS-1 SPEIM GROUNDWATER CHEMICAL MONITORING NETWORK MARCH 2011

AFCEE - Massachusetts Military Reservation 16 March 2011 Technical Update Meeting

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Confirmation Of: <input type="checkbox"/> Meeting <input type="checkbox"/> Change Notice <input checked="" type="checkbox"/> General Project Note	Date Held: 16 March 2011 Location: Date Issued: 29 September 2011 Recorded By: Mark Hilyard
Subject: FS-1 2011 SURFACE WATER MONITORING NETWORK OPTIMIZATION EPA OU-06	Issued By: Nigel Tindall  CH2M HILL TECHNICAL SERVICES GROUP MANAGER

ITEM	REMARKS
1.0	<h3>INTRODUCTION</h3> <p>This project note documents the 2011 optimization of the surface water monitoring network associated with the Fuel-Spill 1 (FS-1) groundwater plume. This optimization of the surface water monitoring network is based upon a review of surface water and groundwater data collected at FS-1 under the System Performance and Ecological Impact Monitoring (SPEIM) program through September 2010, which is documented in the <i>FS-1 2010 Annual SPEIM Data Presentation and Extraction Treatment and Discharge System Optimization</i> project note (Attachment A). In addition, the goal and the objectives for the surface water monitoring network at FS-1 were also reviewed.</p>
2.0	<h3>BACKGROUND</h3> <p>The FS-1 plume is detached from its source area and is defined as the extent of groundwater containing the contaminant of concern (COC), ethylene dibromide (EDB), at concentrations exceeding the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter ($\mu\text{g}/\text{L}$). The FS-1 EDB plume is being remediated through the operation of the FS-1 ETD system, which currently extracts contaminated groundwater via three extraction wells at a combined pumping rate of 515 gallons per minute.</p> <p>Analytical data for the FS-1 plume have been collected through the SPEIM program since startup of a groundwater treatment system in 1999. This program was developed to monitor plume changes and to ensure the effective operation of the groundwater remediation systems; monitoring networks are also evaluated and optimized through the SPEIM program.</p> <p>The current surface water monitoring network at FS-1 was established in 2006 (AFCEE 2007) and is shown in Figure 1 and summarized in Table 1. The surface water monitoring network consists of eight locations and was established to monitor plume discharge to the Quashnet River bogs (based on plume delineation at that time) and provide data to be used for cranberry crop marketability decisions.</p>

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	<p>In 2010, the Mashpee Conservation Commission decided to no longer cultivate these bogs. Therefore data for cranberry marketability decisions are no longer needed. In addition, the SPEIM data collected since 2006 indicate that there has been a significant reduction in the spatial distribution of EDB in the southern portion of the plume (near the Quashnet Bogs). Specifically the volume of the plume in the vicinity of the bogs has greatly reduced and EDB is no longer detected at any monitoring wells located adjacent to the Quashnet Bogs (Figures 2, 4, and 5 of Attachment A).</p> <p>A review of historic surface water data (Figure 1) indicates that EDB has not been detected in samples collected from six of the surface water monitoring locations (36SW0003, 36SW0010, 36SW0036, 36SW0200, 36SW0303, and 36SW4188). However, low concentrations of EDB have intermittently been detected at two locations in the southeastern portion of the bog area (36SW0019 and 36SW4200). Detections ranged between below the laboratory limit (BRL) of 0.01 micrograms per liter ($\mu\text{g}/\text{L}$) to 0.023 $\mu\text{g}/\text{L}$, which are well below the screening-level risk based concentration for imminent human health risk of 6.5 $\mu\text{g}/\text{L}$ and screening level ecological benchmark of 31 $\mu\text{g}/\text{L}$. The source of EDB detections at these two locations is believed to be residual EDB located within a low conductivity unit that underlies the bogs. This small area of EDB contamination is outside the influence of the FS-1 ETD system, is isolated from the FS-1 plume, and is expected to continue to discharge to surface water with decreasing frequency and concentrations over time.</p>
3.0	<p>RECOMMENDATIONS/REGULATOR COMMENTS</p> <p>The following changes to the FS-1 surface water monitoring network were presented to the regulatory agencies at the 11 May 2011 Technical Update Meeting.</p> <ul style="list-style-type: none">• Eliminate six of the surface water locations from the monitoring network at FS-1 (36SW0003, 36SW0010, 36SW0036, 36SW0200, 36SW0303 and 36SW4188) due to the lack of historic EDB detections in surface water and the fact that EDB concentrations at all nearby groundwater monitoring wells have decreased to ND.• Reduce the frequency of sampling at the two remaining locations (36SW0019 and 36SW4200) from 3 times per year (May, July, September) to annually (August). EDB data are no longer needed to assess cranberry marketability, therefore future sampling at these two locations will serve to monitor the discharge to surface water of residual EDB that remains beneath the bogs and is not intended to be captured by the FS-1 ETD system. <p>Based on discussions between AFCEE and the Regulatory Agencies during the 11 May 2011 Technical Update Meeting, it was mutually agreed that the two remaining surface water locations (36SW0019 and 36SW4200; Figure 1) are essentially co-located in terms of monitoring groundwater discharge to surface water (these two locations were established to monitor two distinct surface water locations in terms of cranberry growing [36SW4200 monitored the K5 bog ditch and 36SW0019 monitored the main river channel]). Therefore, it</p>



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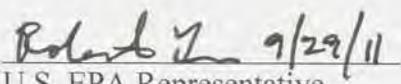
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ITEM	REMARKS
	was agreed surface water location 36SW0019 is most suitable for continued monitoring of plume discharge and will be retained for annual sampling for EDB. Surface water location 36SW4200 will be eliminated for further monitoring. At the 13 July 2011 Technical Update Meeting, the Massachusetts Department of Environmental Protection requested that AFCEE also gain concurrence with the Mashpee Conservation Commission. This concurrence was achieved via e-mail and is attached to the project note as Attachment B.
4.0 CONCLUSIONS	The optimized surface water monitoring network is shown on Figure 2 and summarized in Table 1. Annual sampling for EDB at location 36SW0019 will serve to monitor the discharge of the residual FS-1 EDB plume beneath the bogs to surface water. This small area of EDB contamination is considered to be outside the influence of the FS-1 ETD system and is expected to continue to discharge to the bog area at low concentrations.
5.0 REFERENCE	AFCEE (Air Force Center for Engineering and the Environment). 2007 (January). <i>FS-1 Monitoring Network Optimization</i> Project Note. 337105-SPEIM-FS1 PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
6.0 CONCURRENCE	Concurrence with the optimized FS-1 surface water monitoring network is represented by the signatures below:  U.S. EPA Representative  MassDEP Representative  AFCEE Project Manager Note: The parties involved will retain the ability to modify the monitoring program based on field observations or other mutually agreeable technical justifications.

Attachments:

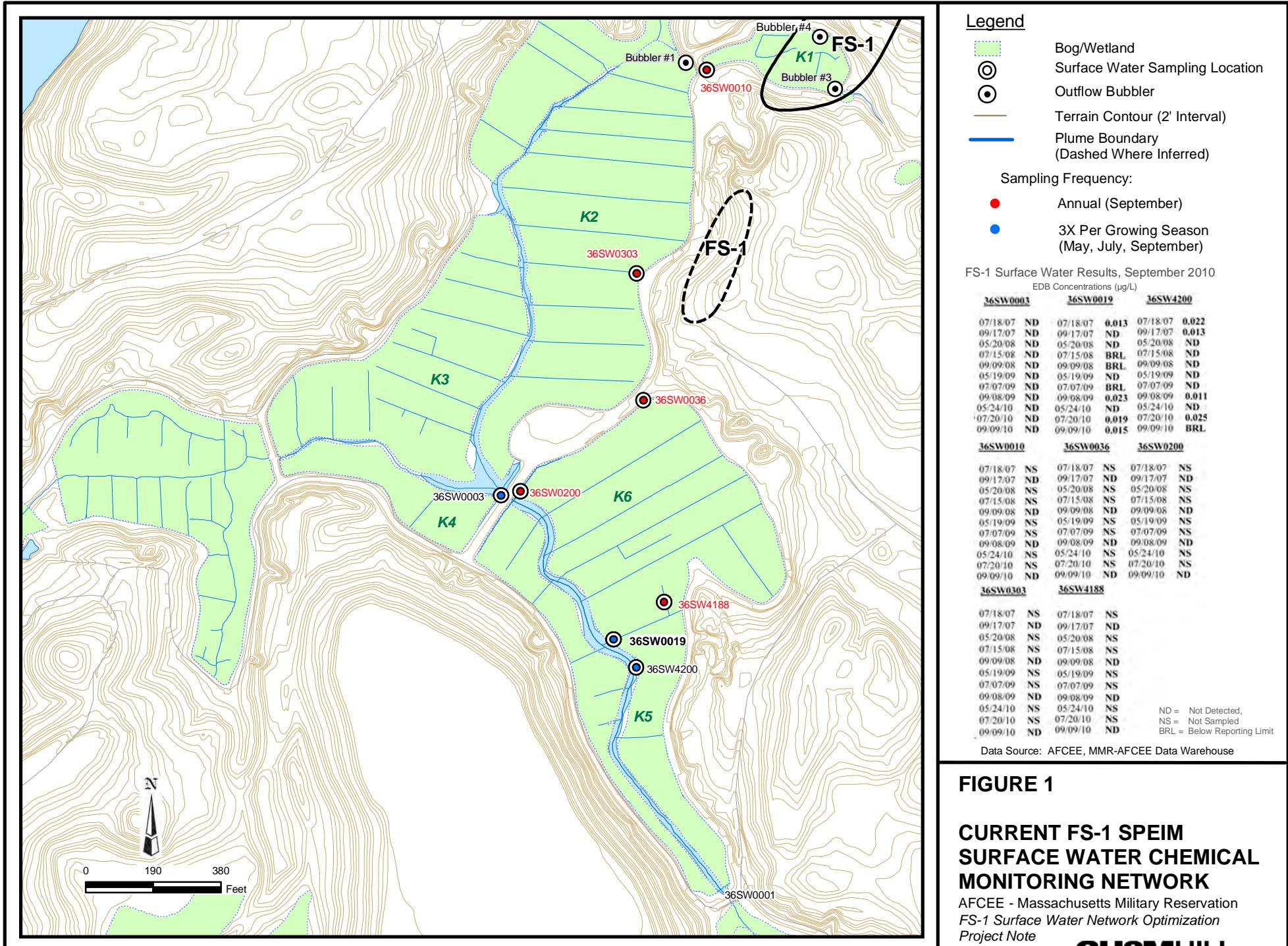
Figure 1: Current FS-1 SPEIM Surface Water Chemical Monitoring Network

Figure 2: Optimized FS-1 SPEIM Surface Water Chemical Monitoring Network

Table 1: Current and Optimized FS-1 SPEIM Surface Water Chemical Monitoring Network

Attachment A: FS-1 2010 Annual SPEIM Data Presentation and ETD Optimization Project Note

Attachment B: Concurrence Correspondence with Mashpee Conservation Commission



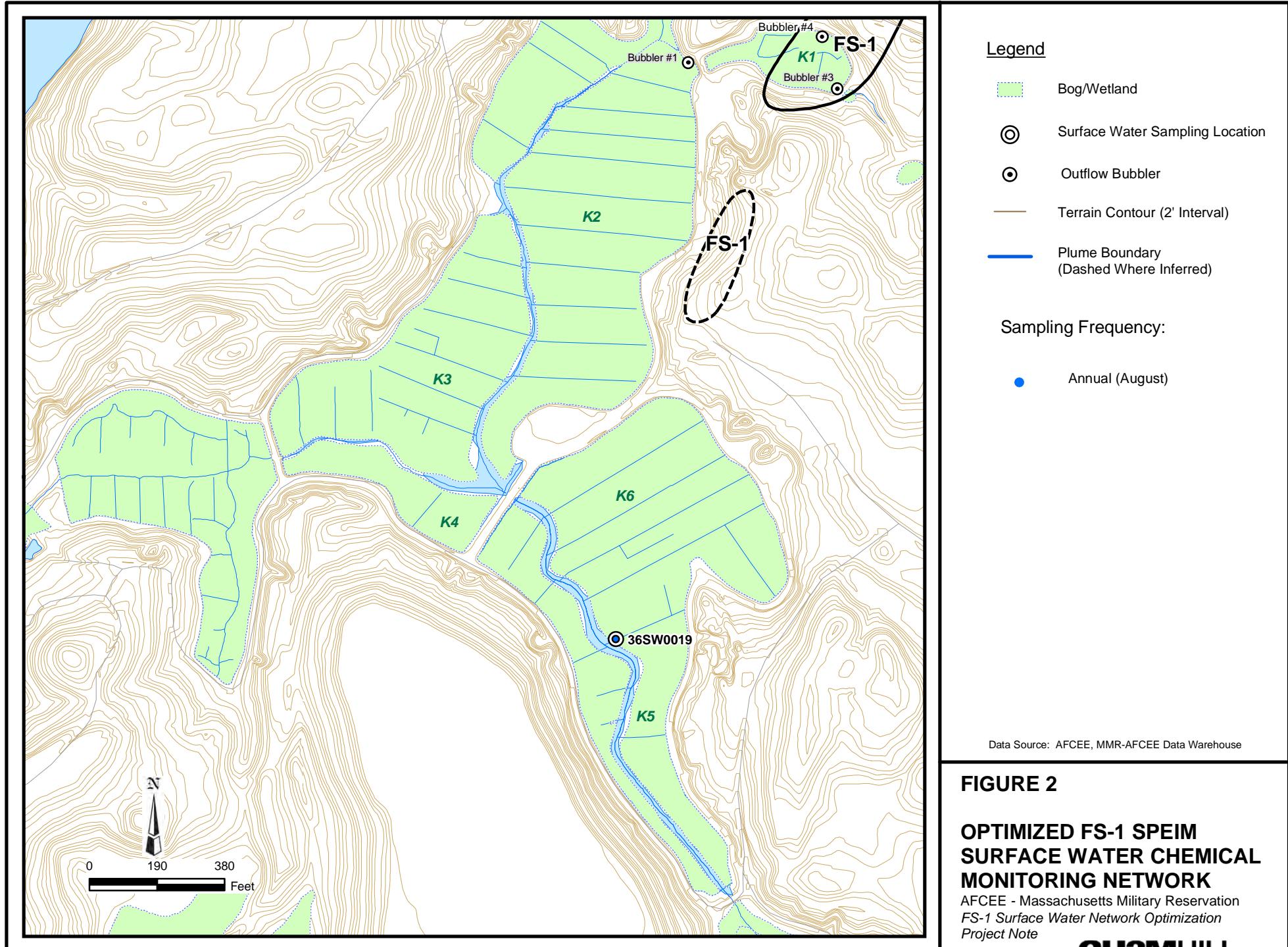


Table 1
Current and Optimized FS-1 SPEIM Surface Water Chemical Monitoring Network
FS-1 2011 Surface Water Monitoring Network Optimization Project Note

Location Identification	Current Frequency	Proposed Frequency	Parameters
36SW0003	3 times per year during growing season*	NM	EDB
36SW0010	A	NM	EDB
36SW0019	3 times per year during growing season*	A	EDB
36SW0036	A	NM	EDB
36SW0200	A	NM	EDB
36SW0303	A	NM	EDB
36SW4188	A	NM	EDB
36SW4200	3 times per year during growing season*	NM	EDB

Key:

A = annually

EDB = ethylene dibromide

FS-1 = Fuel Spill-1

NM = not measured

SPEIM = system performance and ecological impact monitoring

* May, July, and September

ATTACHMENT A



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<p>Confirmation Of:</p> <p><input type="checkbox"/> Meeting</p> <p><input type="checkbox"/> Change Notice</p> <p><input checked="" type="checkbox"/> General Project Note</p>	<p>Date Held: 13 July 2011</p> <p>Location: Large IRP Conference Room</p> <p>Date Issued: 18 July 2011</p> <p>Recorded By: Mark Hilyard</p>
<p>Subject:</p> <p>FS-1 2010 ANNUAL SPEIM DATA PRESENTATION (OCT 2009 – DEC-2010) AND ETD SYSTEM OPTIMIZATION EPA OU-06</p>	<p>Issued By: Nigel Tindall</p> <p></p> <p>CH2M HILL TECHNICAL SERVICES GROUP MANAGER</p>
ITEM	REMARKS
<p>1.0 INTRODUCTION</p> <p>This project note summarizes the Fuel Spill-1 (FS-1) 2010 annual data presentation and plume boundary update that were based on data collected for the FS-1 System Performance and Ecological Impact Monitoring (SPEIM) program between October 2009 and December 2010. In addition, the data presentation included the results of a data gap investigation completed at FS-1 in 2010 and proposed an optimization of the FS-1 extraction, treatment, and discharge (ETD) system. The data presented includes results from the following sampling events:</p> <ul style="list-style-type: none"> • Biennial sampling of 10 monitoring wells (June-10) • Annual sampling of 33 monitoring wells (June-10) • Semiannual sampling of 3 extraction wells (Dec-09/June-10/Dec-10) • Monthly treatment plant sampling (Oct-09 through Dec-10) • Seasonal surface water sampling at Quashnet Bog (May, July, and Sep-10) <p>These data were presented to the regulatory agencies during the 16 March 2011 Technical Update Meeting. The handouts for the presentation included seven figures and presentation text slides. The data presentation is included as Attachment A.</p>	
<p>2.0 BACKGROUND</p> <p>The FS-1 plume is detached from its source area and is defined as the extent of groundwater contaminated with the contaminant of concern (COC), ethylene dibromide (EDB), at concentrations exceeding the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter ($\mu\text{g}/\text{L}$). The FS-1 EDB plume is being remediated through the operation of the FS-1 ETD system, which currently extracts contaminated groundwater via three extraction wells at a combined pumping rate of 515 gallons per minute.</p>	

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	<p>Analytical data for the FS-1 plume have been collected through the SPEIM program since startup of the ETD system in 1999. This program was developed to monitor plume changes and to ensure the effective operation of the AFCEE groundwater remediation systems at the MMR; monitoring networks are also evaluated and optimized through the SPEIM program. The current approved FS-1 SPEIM monitoring network, including analytical scope and methods, is presented in the <i>Comprehensive Long Term Monitoring Plan</i>, which is available on-line at www.mmr.org under Plans and Protocols.</p>
3.0	<p>RESULTS</p> <p>Analytical results and concentration trend graphs were presented for select wells that are monitored throughout the FS-1 plume (Attachment A). Cross-sectional representations of the FS-1 plume, an updated FS-1 plume boundary, and EDB trends in groundwater and surface water were updated using the most recent data. An overview of the ETD system performance for the reporting period was also presented by providing treatment plant influent concentration trends, EDB mass removal, volume of groundwater treated, frequency of carbon exchanges, extraction well operational rates, and air emissions associated with the operation of the system.</p> <p>The data collected under the SPEIM program indicate that the remedial goals for the FS-1 ETD system are being met and that the extent of the plume, particularly south of 36EW0011 has continued to decrease. No EDB was detected in samples collected from monitoring wells located south of Grafton Pocknet Road (Figure 2 of Attachment A). The influent concentrations at the southernmost extraction well (36EW0001) have been sub-MMCL since 2008, most likely due to a decrease in plume extent and lower EDB concentrations in the vicinity of this well. This reduction in plume extent and concentration has likely resulted in the capture of more clean water by this extraction well indicating that the ETD system, and this well in particular, should be evaluated for optimization.</p> <p>Groundwater vertical profiling was conducted at FS-1 in 2010 to better define the extent of the EDB plume south of Grafton Pocknet Road. These data were collected to verify or update the conceptual site model and to support the optimization evaluation for the FS-1 ETD system. The results of groundwater vertical profiling at three locations at the FS-1 plume (Tables 1a and 1b and Figures 3 and 4 of Attachment A) are consistent with the recent data collected under the SPEIM program and confirm that the extent of the FS-1 plume, especially downgradient (i.e., south) of 36EW0011, has decreased significantly since system startup due to the operation of the ETD system and through the processes of natural attenuation. Groundwater vertical profiling results at borings advanced near 36EW0001 (36MW1045A and 36MW1046A) indicate that the extent of the plume in this area is now very limited and any remaining residual EDB detections are deep within the aquifer (>150 feet below ground surface [ft bgs]) as illustrated in Figures 5 and 6 of Attachment A. No EDB was detected at 35MW1046A and sub-MMCL concentrations of EDB was detected at two intervals at 36MW1045A (0.011 µg/L at 160-160 ft bgs and 0.014 µg/L at 180-185 ft bgs).</p>



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	<p>The FS-1 groundwater model was used to simulate the fate and transport of this small area of EDB contamination located near 36EW0001 under a scenario where the extraction well 36EW0001 is turned off and 36EW0005 and 36EW0011 continue to operate at their current flow rates of 175 gpm, and 250 gpm, respectively. In addition, the groundwater model was used to assess any significant changes to the extent of the hydraulic capture at extraction wells 36EW0005 and 36EW0011 when 36EW0001 is turned off. Transport simulations predict that the EDB contamination in the vicinity of 36EW0001 attenuates to sub-MMCL concentrations by 2012. In addition, the modeling results suggest that there is no appreciable change to the extent of the hydraulic capture zones of 36EW0005 and 36EW0011 when 36EW0001 is turned off. Therefore, the remedial performance of these two wells would be unaltered under a scenario where 36EW0001 is shutdown.</p>
4.0	<h3>CONCLUSIONS/RECOMMENDATIONS</h3> <ul style="list-style-type: none">Groundwater EDB concentrations continue to decrease throughout the FS-1 plume monitoring network.The FS-1 plume continues to contract in the aquifer towards the operating extraction wells.Data collected during the 2010 data gap investigation confirm that the size and extent of the FS-1 plume has decreased south of 36EW0011 (South of Grafton Pocknet Road).Additionally the observed reduction in plume volume and/or EDB concentrations appears to be greatest in the vicinity of 36EW0001. Only two sub-MMCL detections of EDB were reported at the groundwater vertical profile locations advanced near 36EW0001 and no EDB was detected in monitoring wells located immediately downgradient or cross-gradient of this extraction well.The reduced volume of the plume near 36EW0001, as indicated by lack of EDB detections in nearby monitoring wells and groundwater vertical profiling locations indicate that this extraction well is no longer contributing to the remediation of the plume.The proposed plume boundary change, as shown on Figure 7 of Attachment A does not affect the current Private Well Land Use Control (LUC) boundary for FS-1.During the 16 March 2011 data presentation, it was recommended that:<ul style="list-style-type: none">The FS-1 EDB plume boundary should be updated as depicted in the data presentation (Attachment A, Figure 7).The FS-1 ETD system should be optimized by turning off 36EW0001. Based on modeling, the fate of the remaining EDB near 36EW0001 is predicted to



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	<p>attenuate to sub-MMCL concentrations by 2012 and remain deep in the aquifer. The attenuation of this small area of EDB contamination can be adequately monitored through a proposed increase of sampling frequency at monitoring wells located immediately downgradient and cross-gradient of the small area of EDB mass (monitoring well clusters 36MW1012A,B,C; 36MW1045A,B; and 36MW0132A,B,C) (Figure 8, Attachment A).</p>
5.0	<p>REGULATOR COMMENTS/ACTION ITEMS</p> <p>During the 16 March Technical Update Meeting, the Massachusetts Department of Environmental Protection (MassDEP) commented that although the extent of the EDB plume is likely very limited in the vicinity of 36EW0001, detectable concentrations of EDB are still reported in the influent at this extraction well (0.017 µg/L in December 2009 – 0.011 µg/L in December 2010). However, this well likely extracts a large volume of clean water from the aquifer over its 60-foot long extraction screen due to the collapse of the EDB plume over the past several years. Therefore, based on the detectable levels of EDB in the influent at extraction well 36EW0001, it is possible that EDB remains at concentrations at or greater than the MMCL of 0.02 µg/L near 36EW0001. Based on this observation, MassDEP requested that additional sampling be completed at 36EW0001 to help determine whether this extraction well should continue to operate; AFCEE concurred with MassDEP's request. The proposed sampling consists of first installing a packer at 36EW0001 so that groundwater is extracted from the bottom 15 feet of well screen; then influent sampling and flow testing will be completed to provide additional data to assess whether EDB is present near 36EW0001 at concentrations above the MMCL. The results of this additional testing will be shared with the regulatory agencies and a path forward regarding the optimization of 36EW0001 will be formulated through the technical update meeting progress.</p> <p>A check-in with regulatory agencies was made at the 11 May 2011 Technical Update Meeting and no additional comments regarding the proposed FS-1 plume boundary or other conclusions resulting from the annual data presentation were received. The installation of the packer at 36EW0001 was pending as of the 11 May Technical Update Meeting. Therefore this project note serves only to document the regulatory concurrence with the new plume boundary at FS-1 as well as the path forward for additional optimization sampling at 36EW0001. No changes to the FS-1 monitoring network will be made at this time. The results of the optimization sampling at 36EW0001 and the path forward for the optimization of this well will be documented in a future project note.</p>

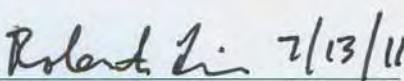
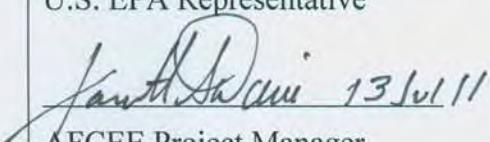
PROJECT NOTE

TASK ORDER
0244PROJECT NO.
404929

AFCEE
SPEIM/LTM/O&M
Otis ANG Base, Massachusetts
AFCEE 4P08-FA8903-08-D-8769

DOCUMENT CONTROL NUMBER:
404929-SPEIM-FS1-PRJNOT-001
CDRL B008

PAGE 5 OF 5

ITEM	REMARKS
6.0	<p>CONCURRENCE</p> <p>Concurrence with the updated FS-1 plume boundary presented during the FS-1 2010 SPEIM annual data presentation (Attachment A) is represented by the signatures below:</p> <p> 7/13/11 U.S. EPA Representative</p> <p> 7/13/2011 MassDEP Representative</p> <p> 13 Jul 11 AFCEE Project Manager</p> <p>Note: The parties involved will retain the ability to modify the FS-1 plume boundary based on field observations or other mutually agreeable technical justifications.</p>

Attachment:

Attachment A: FS-1 2010 Annual SPEIM Data Presentation and ETD System Optimization, 16 March 2011 Technical Update Meeting

ATTACHMENT A

FS-1 2010 Annual SPEIM Data Presentation and ETD System Optimization

16 March 2011 Technical Update Meeting

Presentation Overview

- SPEIM Results
- Data Gap Investigation results (plan presented during 2009 Annual Update, field work completed in December 2010)
- ETD system optimization

FS-1 2010 Annual SPEIM Data Presentation

SPEIM Overview

- Sampling dates: Oct-09 through Dec-10
- Sampling locations and plume boundary (Figure 1):
 - Biennial sampling of 10 monitoring wells (June-10)
 - Annual sampling of 33 monitoring wells (June -10)
 - Semiannual sampling of 3 extraction wells (Dec-09/June-10/Dec-10)
 - Monthly sampling of treatment plant influent (Oct-09 through Dec-10)
 - Surface water sampling at Quashnet Bog (May, July and Sep-10)
- Trend analysis
 - Comparison of current data to previous result for each location
 - Trend plots for key monitoring wells

FS-1 2010 Annual SPEIM Data Presentation

SPEIM Overview (continued)

- Remedial system performance
- Data gap results (groundwater vertical profiling for EDB)
- FS-1 CSM review and plume boundary update

FS-1 2010 Annual SPEIM Data Presentation

Highlights of Data Review (Figure 1)

- EDB concentrations north of 36EW0011
 - 36MW0503 cluster continue to decrease
 - “A” screen: 0.074 µg/L (down from 0.264 µg/L in 2008)
 - “B” screen: ND (down from BRL in 2008)
 - “C” screen: ND (down from BRL in 2008)
 - 36MW1039 cluster ND or decreasing:
 - “A” and “B” screens remain ND
 - 36MW1038 cluster remain ND
 - 36MW1040 cluster decreasing
 - “A” screen 0.029 µg/L (down from 0.047 µg/L in June-09).
 - “B” screen remains ND
 - 36MW1041 cluster ND or decreasing:
 - “A” screen 0.454 µg/L (down from 0.857 µg/L in June-09).
 - “B” and “C” screens remain ND

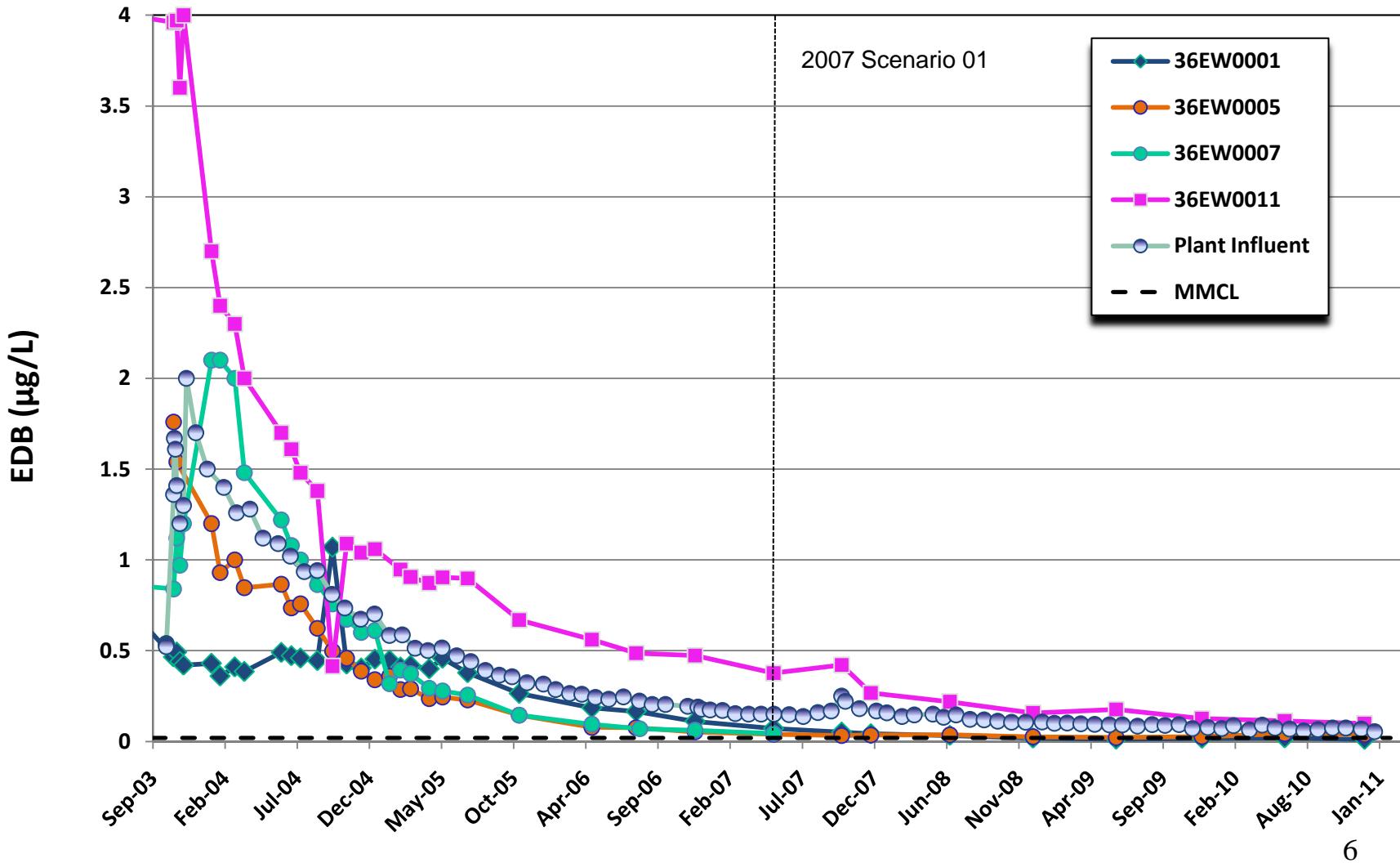
FS-1 2010 Annual SPEIM Data Presentation

Highlights of Data Review (cont)

- Concentrations south of Grafton Pocknet Road (Figure 2 –hits map)
 - No detects at existing groundwater monitoring locations, south of Grafton Pocknet Road
 - 36MW1010A,B, and C and 36PZ1010 remain ND.
 - 36MW1003A ND (Down from BRL in June-09); 36PZ1003 remains ND.
 - 36MW1014A,B remain ND.
 - 36EW4020 remains ND.
 - 36MW1012A,C remain ND; “B” screen ND (down from 0.016 µg/L in June-09).
 - 36PZ1002 cluster remain ND.
 - 36MW0131B and C remain ND; “A” screen ND (down from BRL in June-09)
 - 36MW0132A,B, and C remain ND
 - 36MW0136 remains ND

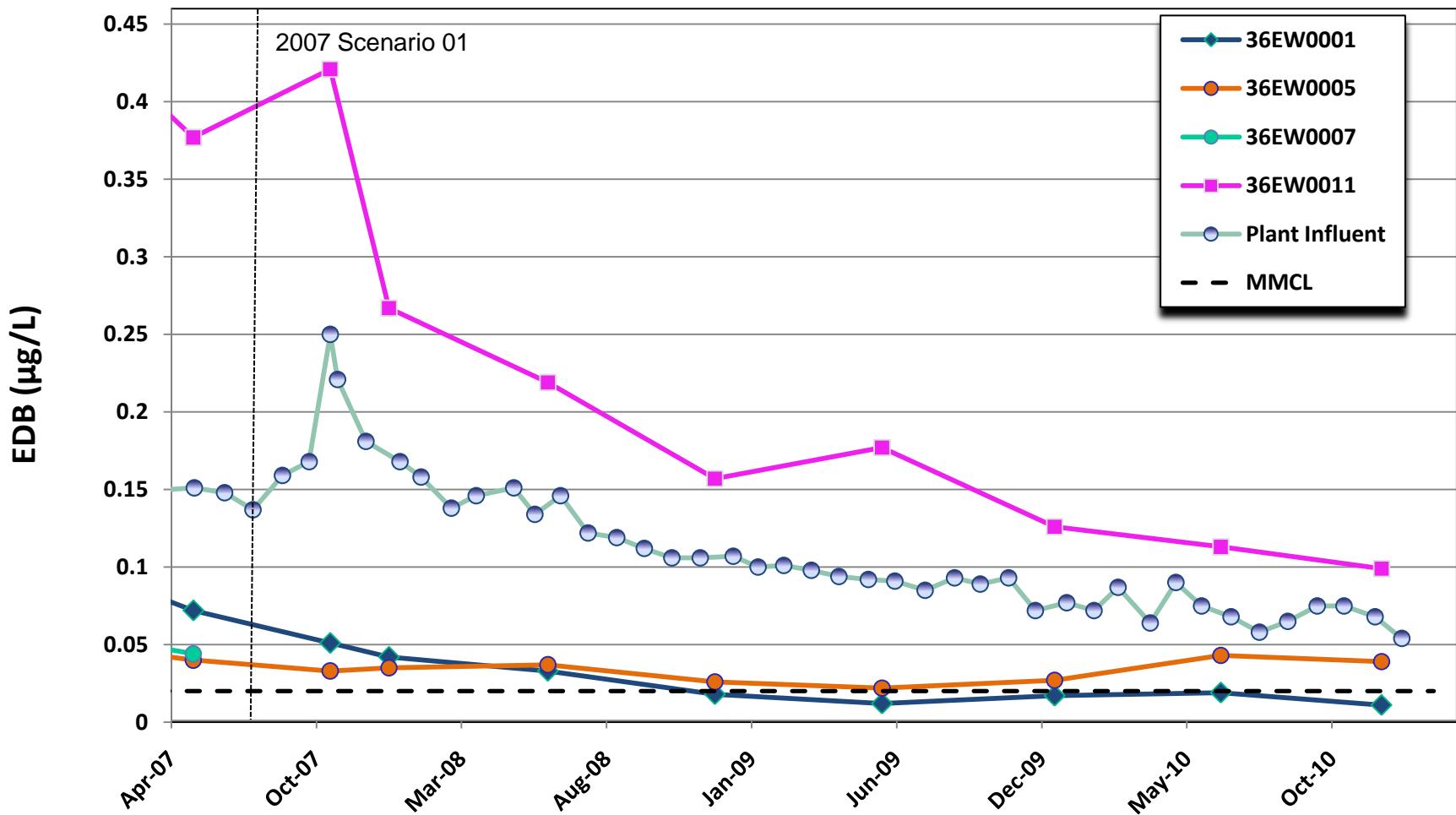
FS-1 2010 Annual SPEIM Data Presentation

FS-1 Extraction Well and Plant Influent Data (2003-present)



FS-1 2010 Annual SPEIM Data Presentation

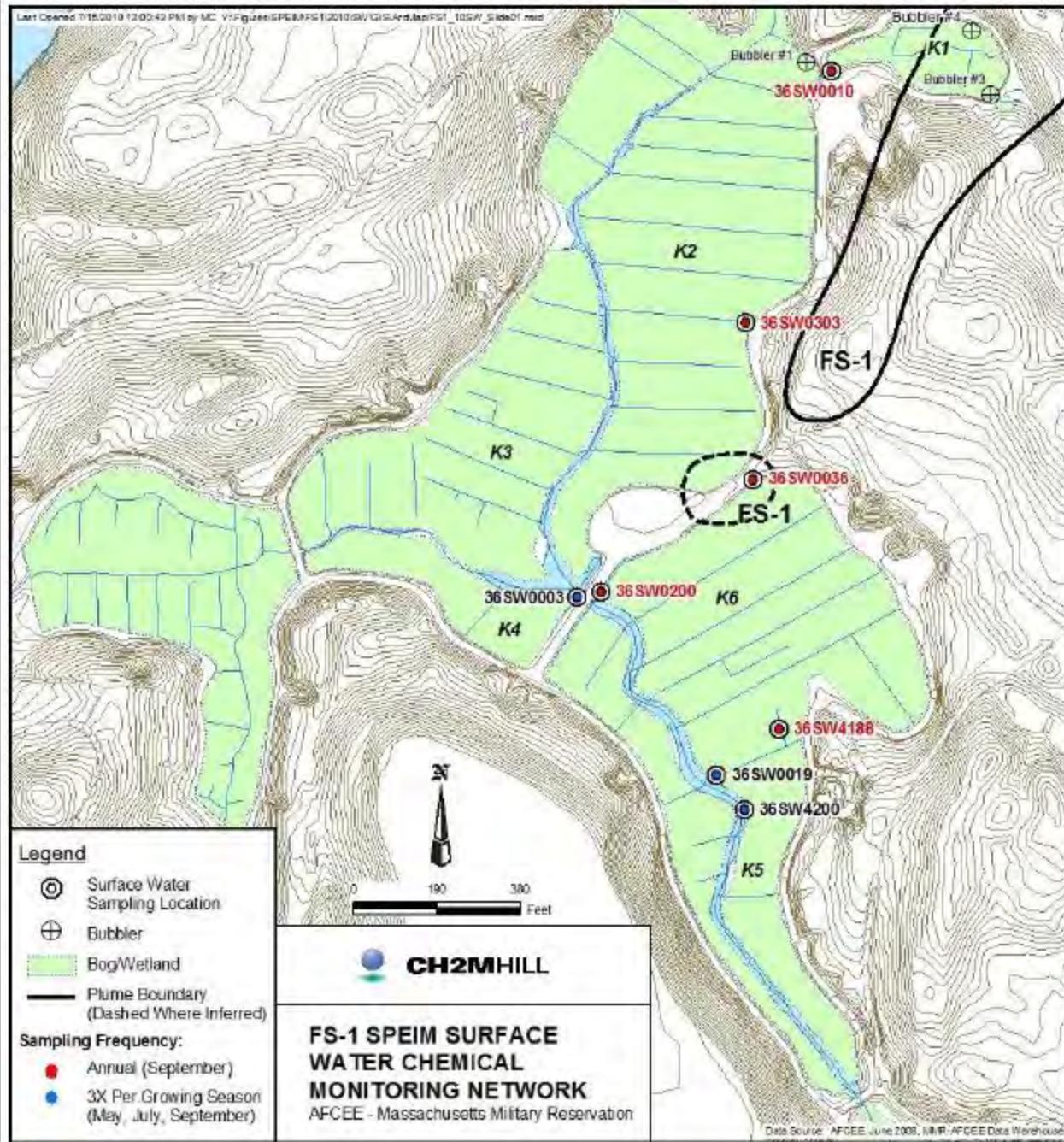
FS-1 Extraction Well and Plant Influent Data - 5 Year Overview



FS-1 2010 Annual SPEIM Data Presentation

ETR System Summary

- Approximately 329 million gallons of groundwater treated by ETR system (Oct-09 to Dec-10)
- 0.202 pounds of EDB removed; 17.76 pounds since system startup
- 2 carbon exchanges
- Extraction wells operated between 95%-99% design rates
- Electrical usage and related air emissions will be reported in the 2010 SLR



FS-1 Surface Water Results September 2010

EDB Concentrations (µg/L)

	<u>36SW0003</u>	<u>36SW0019</u>	<u>36SW4200</u>	
07/18/07	ND	07/18/07	0.013	07/18/07
09/17/07	ND	09/17/07	ND	09/17/07
05/20/08	ND	05/20/08	ND	05/20/08
07/15/08	ND	07/15/08	BRL	07/15/08
09/09/08	ND	09/09/08	BRL	09/09/08
05/19/09	ND	05/19/09	ND	05/19/09
07/07/09	ND	07/07/09	BRL	07/07/09
09/08/09	ND	09/08/09	0.023	09/08/09
05/24/10	ND	05/24/10	ND	05/24/10
07/20/10	ND	07/20/10	0.019	07/20/10
09/09/10	ND	09/09/10	0.015	09/09/10
			BRL	
	<u>36SW0010</u>	<u>36SW0036</u>	<u>36SW0200</u>	
07/18/07	NS	07/18/07	NS	07/18/07
09/17/07	ND	09/17/07	ND	09/17/07
05/20/08	NS	05/20/08	NS	05/20/08
07/15/08	NS	07/15/08	NS	07/15/08
09/09/08	ND	09/09/08	ND	09/09/08
05/19/09	NS	05/19/09	NS	05/19/09
07/07/09	NS	07/07/09	NS	07/07/09
09/08/09	ND	09/08/09	ND	09/08/09
05/24/10	NS	05/24/10	NS	05/24/10
07/20/10	NS	07/20/10	NS	07/20/10
09/09/10	ND	09/09/10	ND	09/09/10
	<u>36SW0303</u>	<u>36SW4186</u>		
07/18/07	NS	07/18/07	NS	
09/17/07	ND	09/17/07	ND	
05/20/08	NS	05/20/08	NS	
07/15/08	NS	07/15/08	NS	
09/09/08	ND	09/09/08	ND	
05/19/09	NS	05/19/09	NS	
07/07/09	NS	07/07/09	NS	
09/08/09	ND	09/08/09	ND	
05/24/10	NS	05/24/10	NS	
07/20/10	NS	07/20/10	NS	
09/09/10	ND	09/09/10	ND	

ND = Not Detected, NS = Not Sampled

BRL = below reporting limit

FS-1 2010 Annual SPEIM Data Presentation

Field Data Gap Investigation (Figure 3)

- SPEIM monitoring indicated there was an opportunity to optimize 36EW0001
- Needed to better characterize EDB mass south of Grafton Pocknet Road
- Groundwater vertical profiling attempted with direct push rig at three locations in May 2010; met with shallow refusal at all 3 locations (results presented at 23 June 2010 Technical Update Meeting)
- 2 locations near 36EW0001 were completed to bedrock in December 2010 using sonic drilling techniques (36MW1045A and 36MW1046A; Tables 1a and 1b)

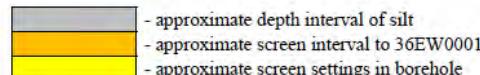
FS-1 2010 Annual SPEIM Data Presentation

Sonic Drilling Update- 36MW1045A

Table 1a
Borehole Groundwater Screening Results
FS-1 Direct Push and Sonic Location
36DP0101 and 36MW1045A

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02 µg/L
A	5/18/2010	25	30	27.5	30.5	ND
B	5/18/2010	35	40	37.5	20.5	ND
C	5/18/2010	45	50	47.5	10.5	ND
D	5/18/2010	55	60	57.5	0.5	ND
E	5/18/2010	65	70	67.5	-9.5	ND
F	5/18/2010	75	80	77.5	-19.5	ND
G	5/19/2010	85	90	87.5	-29.5	ND
H	5/19/2010	95	100	97.5	-39.5	NS
I	5/19/2010	105	110	107.5	-49.5	ND
A	12/5/2010	110	115	112.5	-54.5	ND
B	12/5/2010	120	125	122.5	-64.5	ND
C	12/6/2010	130	135	132.5	-74.5	ND
D	12/6/2010	140	145	142.5	-84.5	ND
E	12/6/2010	150	155	152.5	-94.5	NS
F	12/6/2010	160	165	162.5	-104.5	0.011
G	12/6/2010	170	175	172.5	-114.5	ND
H	12/6/2010	180	185	182.5	-124.5	0.014
I	12/7/2010	190	195	192.5	-134.5	ND
J	12/7/2010	200	205	202.5	-144.5	NS
K	12/7/2010	210	215	212.5	-154.5	NS
L	12/7/2010	220	225	222.5	-164.5	ND
M	12/7/2010	230	235	232.5	-174.5	ND
N	12/7/2010	240	245	242.5	-184.5	NS
O	12/7/2019	250	255	252.5	-194.5	NS
P	12/7/2019	260	265	262.5	-204.5	NS

Data Source: AFCEE-MMR Data warehouse



Key:

BOS = bottom of sample
 BRL = below reporting limit
 EDB = ethylene dibromide
 ft bgs = feet below ground surface
 ft msl = feet mean sea level

MMCL = Massachusetts Maximum Contaminant Level
 ND = not detected
 NS = no sample collected
 TOS = top of sample
 µg/L = micrograms per liter

Notes:

Approximate elevation of ground surface is 58 ft msl.
 Bedrock encountered at 267 ft bgs
 Monitoring wells were installed at 180-185 ft bgs (A screen) and 115-120 ft bgs (B screen)

FS-1 2010 Annual SPEIM Data Presentation

Sonic Drilling Update – 36MW1046A

Table 1b
Borehole Groundwater Screening Results
FS-1 Direct Push and Sonic Locations
36DP0102 and 36MW1046A

Sample Interval	Date Sampled	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02 µg/L
A	5/21/2010	25	30	27.5	29.5	ND
B	5/21/2010	35	40	37.5	19.5	ND
C	5/21/2010	45	50	47.5	9.5	ND
D	5/21/2010	55	60	57.5	-0.5	ND
E	5/25/2010	65	70	67.5	-10.5	ND
F	5/25/2010	75	80	77.5	-20.5	ND
G	5/25/2010	85	90	87.5	-30.5	ND
H	5/25/2010	93	98	95.5	-38.5	ND
I	5/26/2010	105	110	107.5	-50.5	ND
J	5/26/2010	110	115	112.5	-55.5	ND
A	12/10/2010	110	115	112.5	-55.5	ND
B	12/10/2010	120	125	122.5	-65.5	ND
C	12/10/2010	130	135	132.5	-75.5	ND
D	12/10/2010	140	145	142.5	-85.5	ND
E	12/10/2010	150	155	152.5	-95.5	ND
F	12/10/2010	160	165	162.5	-105.5	ND
G	12/13/2010	170	175	172.5	-115.5	ND
H	12/13/2010	180	185	182.5	-125.5	ND
I	12/13/2010	190	195	192.5	-135.5	ND
J	12/13/2010	200	205	202.5	-145.5	NS
K	12/14/2010	210	215	212.5	-155.5	NS
L	12/14/2010	220	225	222.5	-165.5	ND
M	12/14/2010	230	235	232.5	-175.5	NS
N	12/14/2010	240	245	242.5	-185.5	NS
O	12/14/2010	250	255	252.5	-195.5	NS
P	12/14/2010	260	265	262.5	-205.5	NS

Data Source: AFCEE-MMR Data warehouse

 - approximate depth interval of silt

Key:

BOS = bottom of sample
 BRL = below reporting limit
 EDB = ethylene dibromide
 ft bgs = feet below ground surface
 ft msl = feet mean sea level

MMCL = Massachusetts Maximum Contaminant Level
 ND = not detected
 NS = no sample collected
 TOS = top of sample
 µg/L = micrograms per liter

Notes:

Approximate elevation of ground surface is 57 ft msl.
 Bedrock encountered at 267 ft bgs
 No monitoring wells were installed at this location.

FS-1 2010 Annual SPEIM Data Presentation

Findings -Field Data Gap Investigation (Figure 3)

- No EDB plume between 36EW0001 and 36MW0136
- Remaining EDB in capture zone of 36EW0001 is likely to be low concentration, very limited in extent.
- EDB detects in surface water at Quashnet Bog are isolated from main plume.

FS-1 2010 Annual SPEIM Data Presentation

FS-1 CSM and Boundary Update

- Cross-Section A-A' (Figure 4)
 - Most plume mass is upgradient of 36EW0011
 - Plume volume has decreased downgradient of 36EW0011
- Cross-Section B-B' (Figure 5)
 - Plume not present between 36EW0001 and 36MW0136
 - Remaining EDB in 36EW0001 capture zone likely near bottom of EW screen
- EDB Concentration Trends and Revised Plume Boundary (Figure 6)
 - EDB concentration trends are decreasing throughout plume.
 - Volume of plume south of 36EW0011 has been significantly reduced
 - EDB within capture zone of 36EW0001 likely low concentration and limited in extent.
- EDB detections in surface water continue to be intermittent, related to remnants of the uncaptured portion of the plume beneath the bogs.
- 36EW0001 should be optimized

FS-1 ETD System Optimization

- SPEIM monitoring data and groundwater vertical profile results indicate that mass and volume of EDB remaining within the capture zone to 36EW0001 is very low and limited in extent.
 - Influent has been sub-MMCL since December 2008.
 - No detections of EDB at monitoring wells located with capture zone to 36EW0001.
 - Sub-MMCL EDB concentrations reported in only 2 intervals at a groundwater vertical profile (36MW1045A) advanced approximately 85 feet cross-gradient to the well
- Detections of EDB in surface water are the result of residual EDB that is outside the influence of the ETD system and is isolated from the FS-1 plume.
- As a result, the operation of 36EW0001 is no longer contributing to the remediation of the plume.
- The existing groundwater model was used to predict the plume transport and extent of hydraulic capture with 36EW0001 turned off.

FS-1 ETD System Optimization

Groundwater Modeling Support and Analysis:

- Advanced the 2007 plume shell until the simulation matched the results of the most recent SPEIM groundwater data set. The 2013 time step of the transport simulation most closely matches the most recent SPEIM groundwater data set .
- The transport simulation was baselined by assigning the 2013.5 simulation time step as 2010. Then the groundwater model was used to simulate plume shell transport with 36EW0001 turned off in 2011 and 36EW0005 and 36EW0011 pumping at current flow rates (175 and 200 gpm, respectively)
- In addition, the groundwater model was used to evaluate impacts, if any, to the hydraulic capture zones of 36EW0005 and 36EW0011 with 36EW0001 turned off.

FS-1 ETD System Optimization

RESULTS

- Transport simulations predict that the EDB mass within the capture zone to 36EW0001 attenuates in the aquifer to sub-MMCL concentrations by 2012.
- No appreciable change to the capture zones of 36EW0005 and 36EW0011 with 36EW0001 turned off.

FS-1 ETD System Optimization

Conclusions – ETD Optimization

- ✓ Continuing to operate 36EW0001 will no longer contribute to remediation of the plume
- ✓ Extent of plume capture by 36EW0005 and 36EW0001 is unaffected by the shutdown of 36EW0001
- ✓ Mass removal efficiency of the ETD system is expected to increase when 36EW0001 is turned off
- ✓ Sufficient network is available to monitor groundwater immediately downgradient of 36EW0001 (Figure1)

FS-1 ETD System Optimization

Recommendations –SPEIM Data Presentation and ETD Optimization

- ✓ Update plume boundary as depicted in Figures 4,5 and 6
 - No changes to FS-1 LUC boundary or parcel count (Figure 7)
- ✓ Optimize the FS-1 ETD system by shutting down 36EW0001 and operating 36EW0005 and 36EW0011 at current flow rates (175 gpm, and 250 gpm respectively)
 - New pumping configuration will be called 2010 Scenario 01
- ✓ Increase frequency of sampling at 36MW0132A,B,C and 36MW1012A,B,C from annual to semiannual and add new monitoring wells 36MW1045A,B at a semiannual frequency (Figure 8).
- ✓ Conduct annual SPEIM sampling event in May 2011 and a semiannual event in December 2011 .
- ✓ Optimize FS-1 SPEIM network based on data collected through December 2011.

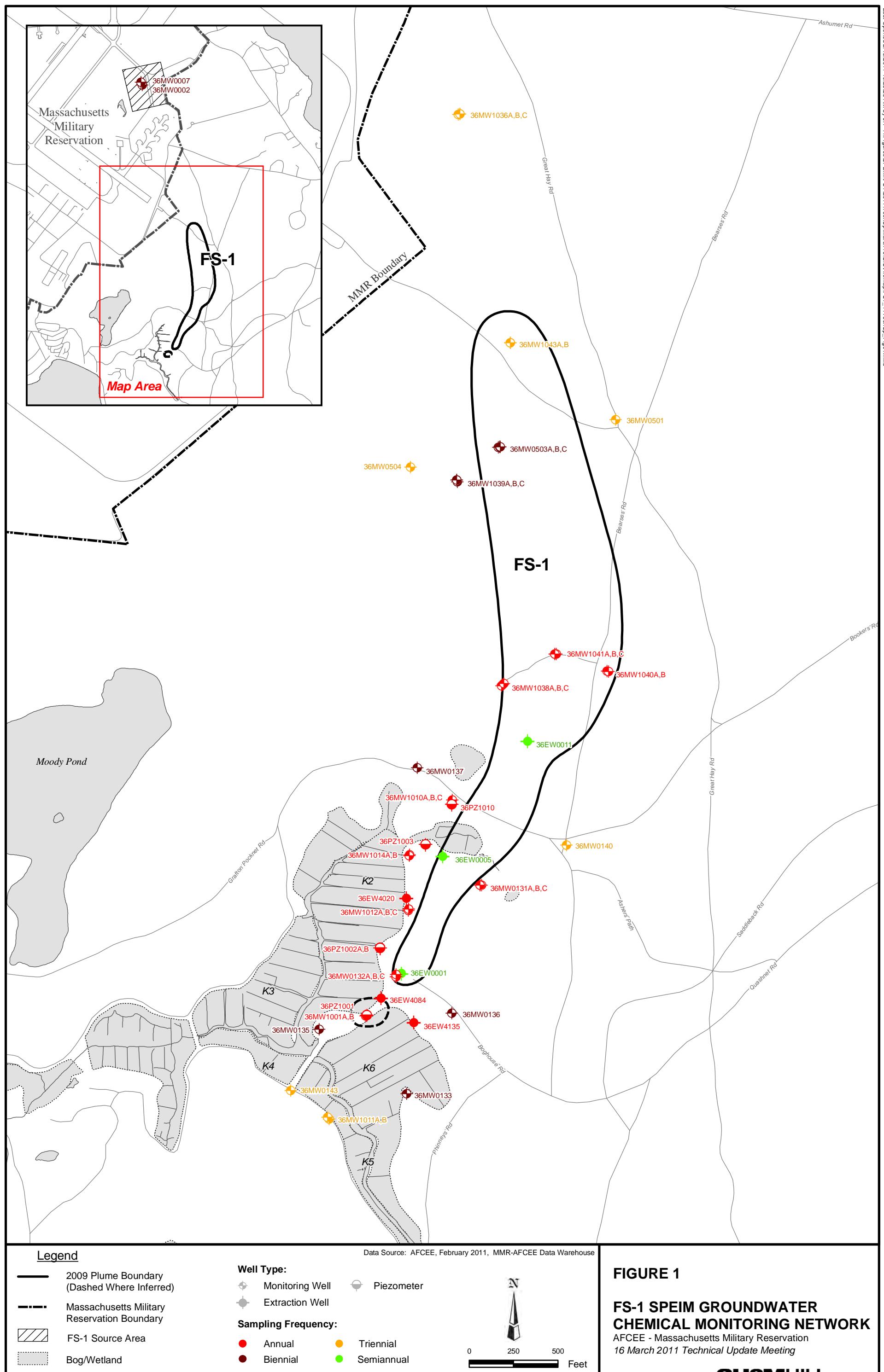
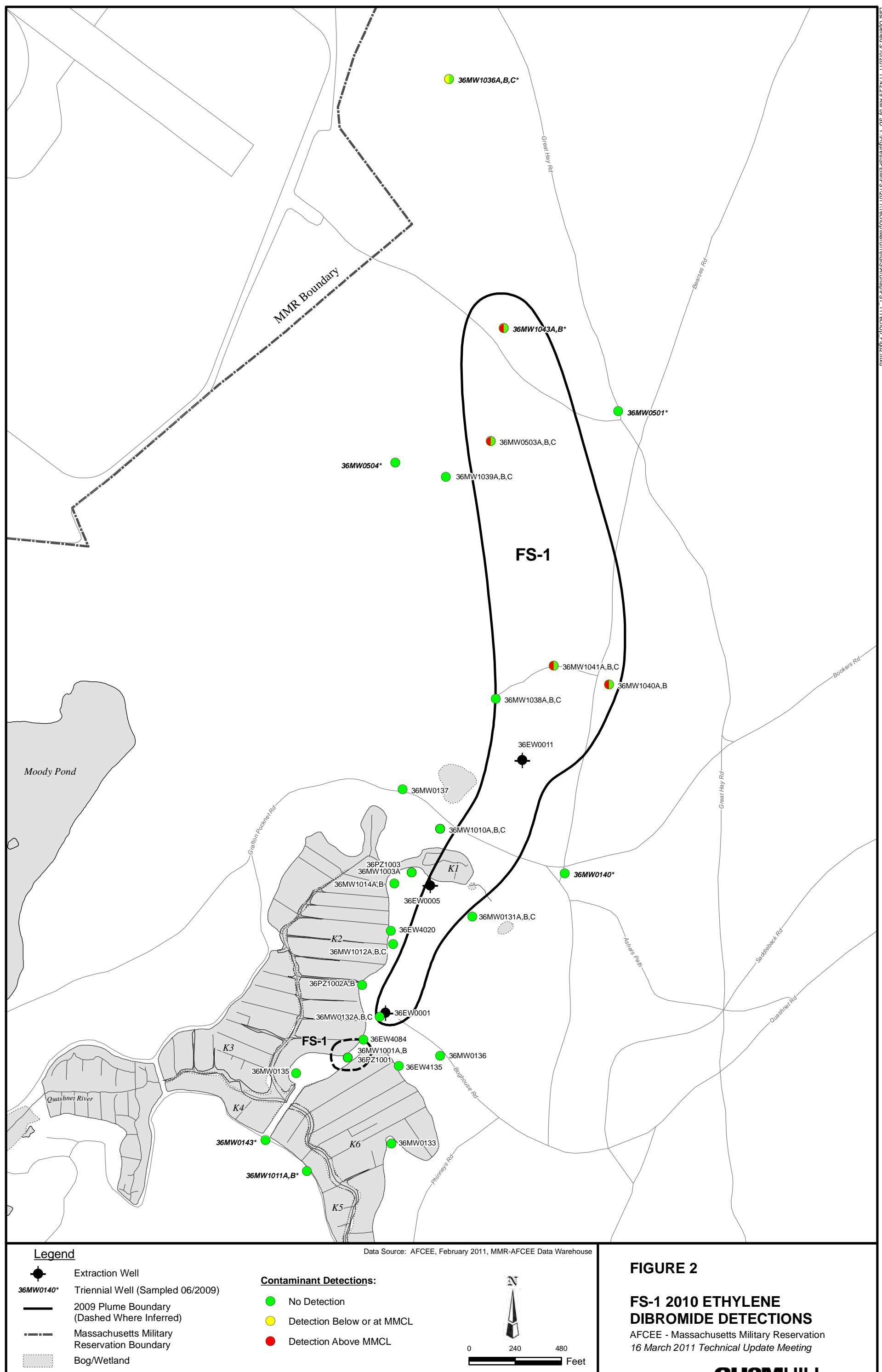


FIGURE 1

FS-1 SPEIM GROUNDWATER CHEMICAL MONITORING NETWORK

AFCEE - Massachusetts Military Reservation
16 March 2011 Technical Update Meeting





Legend

- Extraction Well
- Monitoring Well
- Piezometer
- ▼ Direct Push
- Sonic Locations
- Massachusetts Military Reservation Boundary
- Plume Boundary (Dashed Where Inferred)
- Cross-Section Line
- Bog/Wetland

Data Source: AFCEE, February 2011, MMR-AFCEE Data Warehouse

N

0 290 580 Feet

FIGURE 3

FS-1 EDB PLUME AND LOCATION OF CROSS-SECTION LINES
AFCEE - Massachusetts Military Reservation
16 March 2011 Technical Update Meeting

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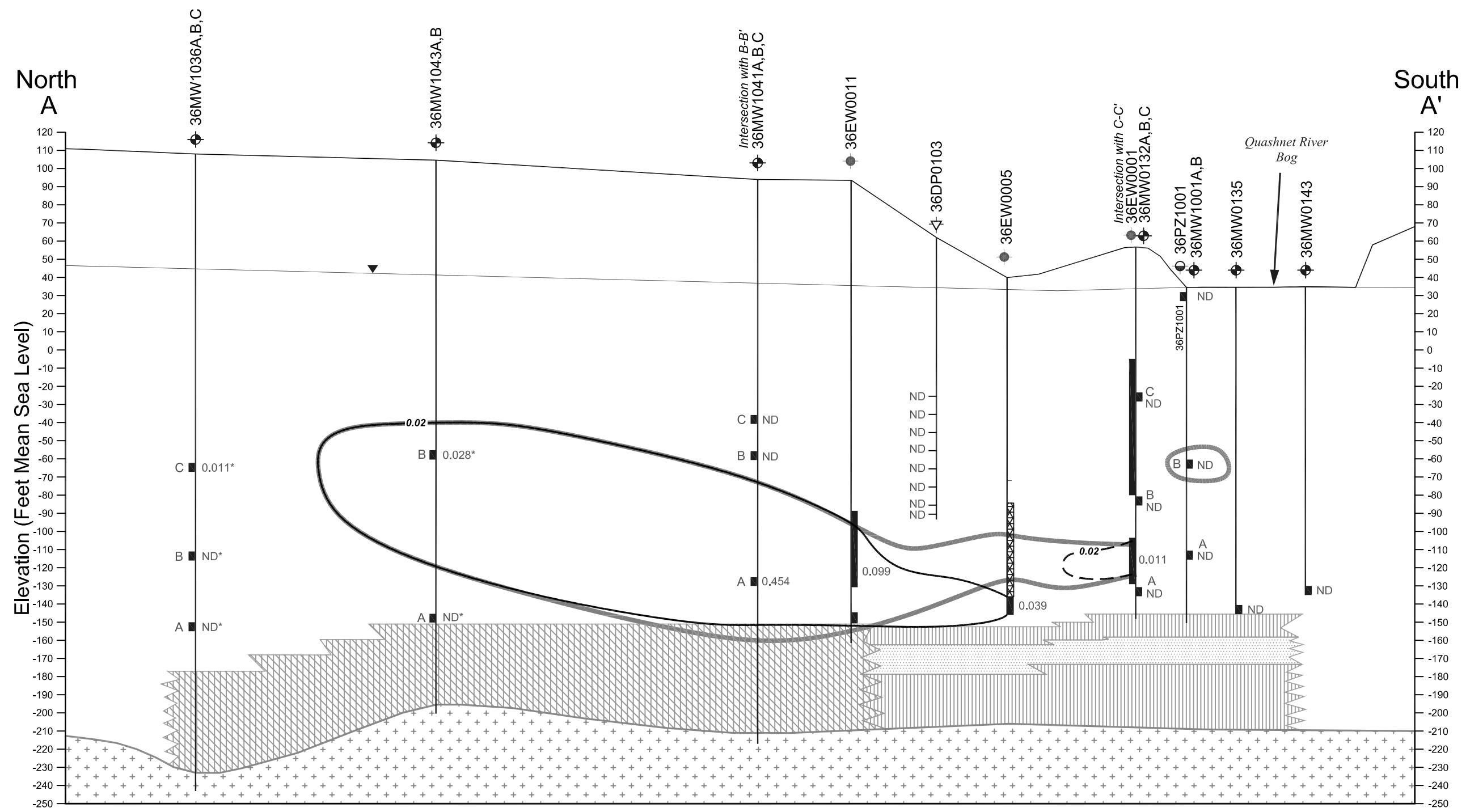
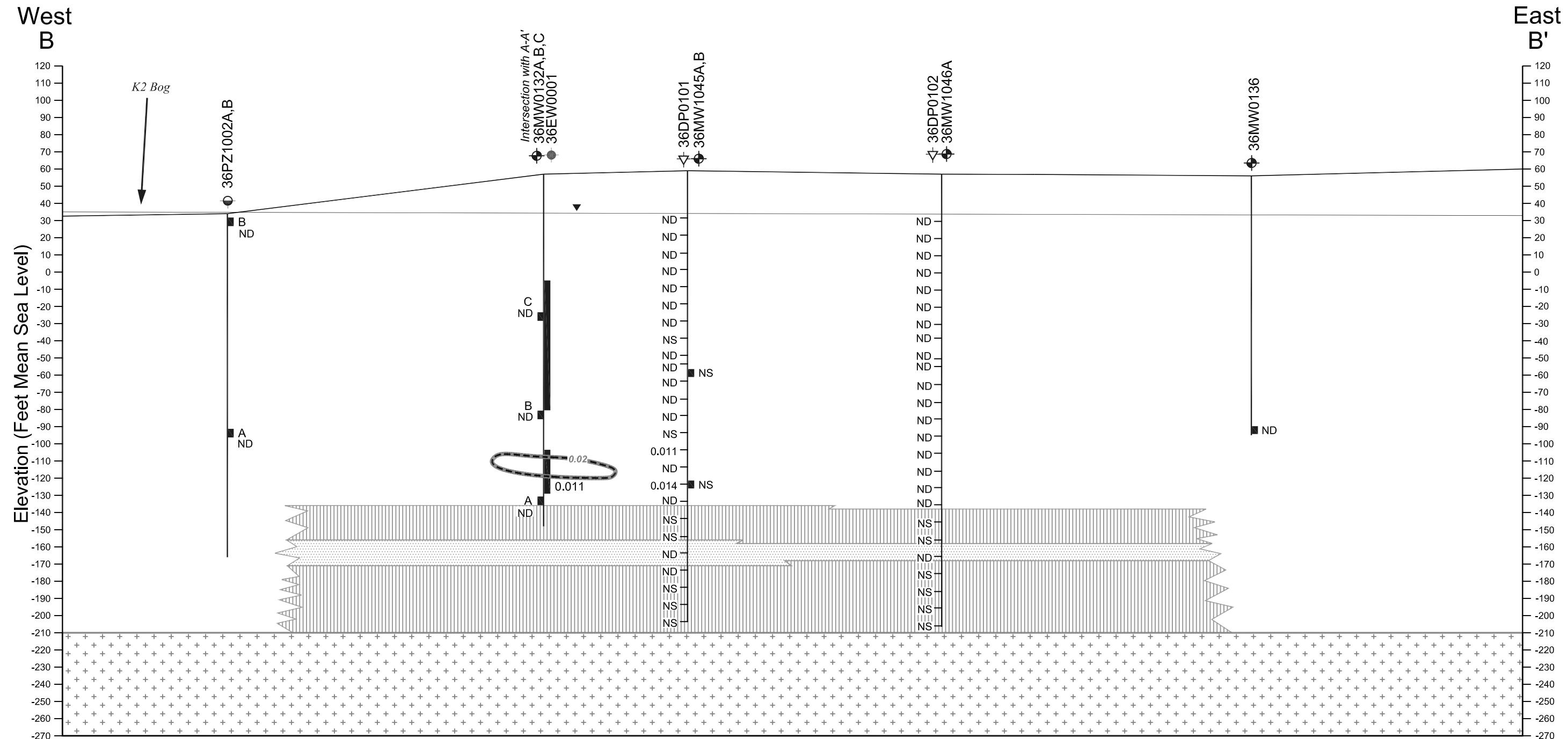


FIGURE 4

FS-1 CROSS-SECTION A-A'

AFCEE - Massachusetts Military Reservation
16 March 2011 Technical Update Meeting



Legend

- | | | | | | |
|---|-----------------|---|---|--|---------------------------------|
|  | Monitoring Well |  | 2010 EDB Isoconcentration Contour (Dashed Where Inferred) |  | Vertical Profile Results (2010) |
|  | Piezometer | | |  | Most Recent EDB Results (µg/L) |
|  | Extraction Well |  | Former EDB Isoconcentration Contour (2009) |  | Nondetect |
|  | Direct Push | | |  | Not Sampled |
|  | Water Table |  | Well Screen |  | |

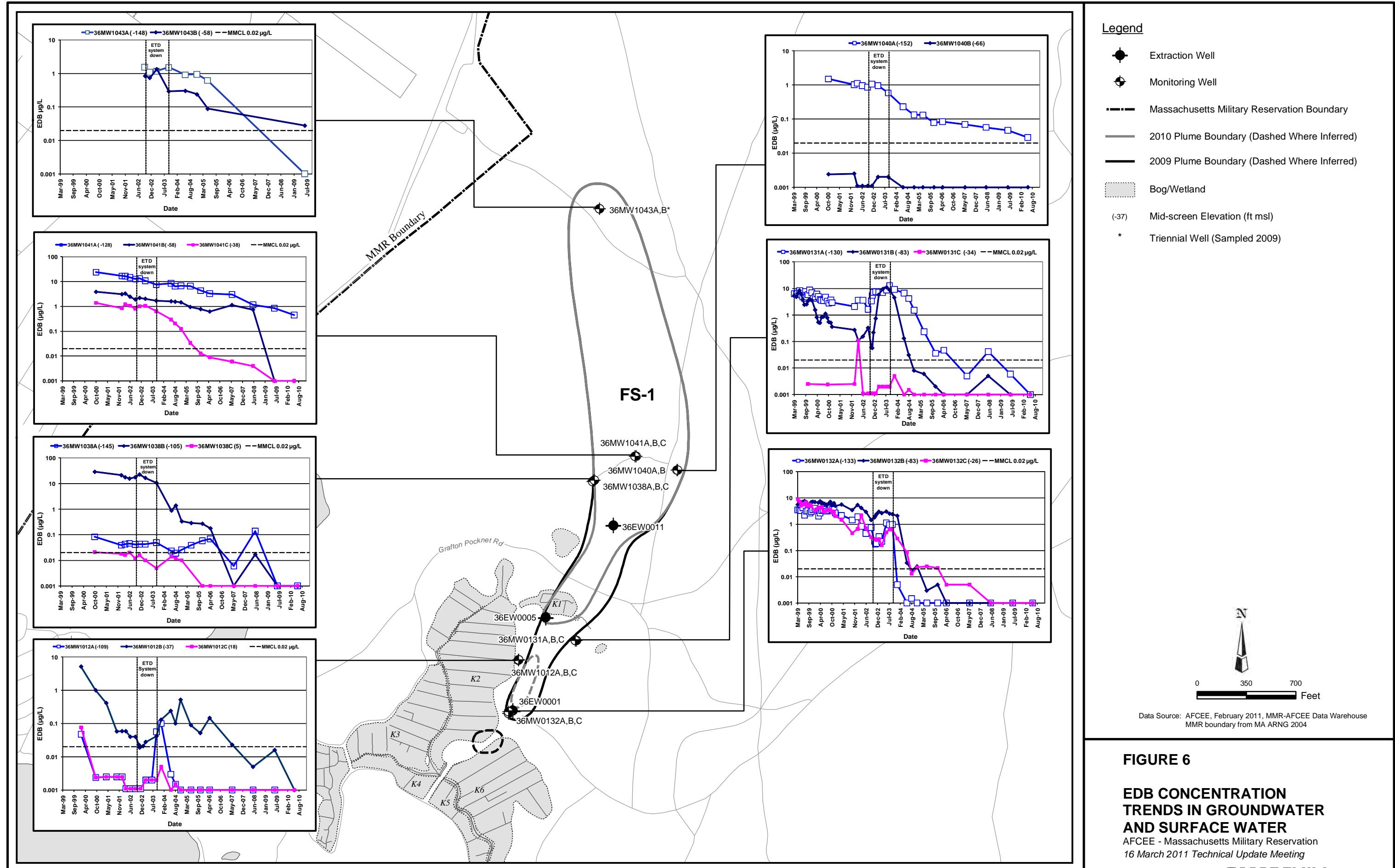
Data Source: February 2011, AFCEE, MMR-AFCEE Data Warehouse

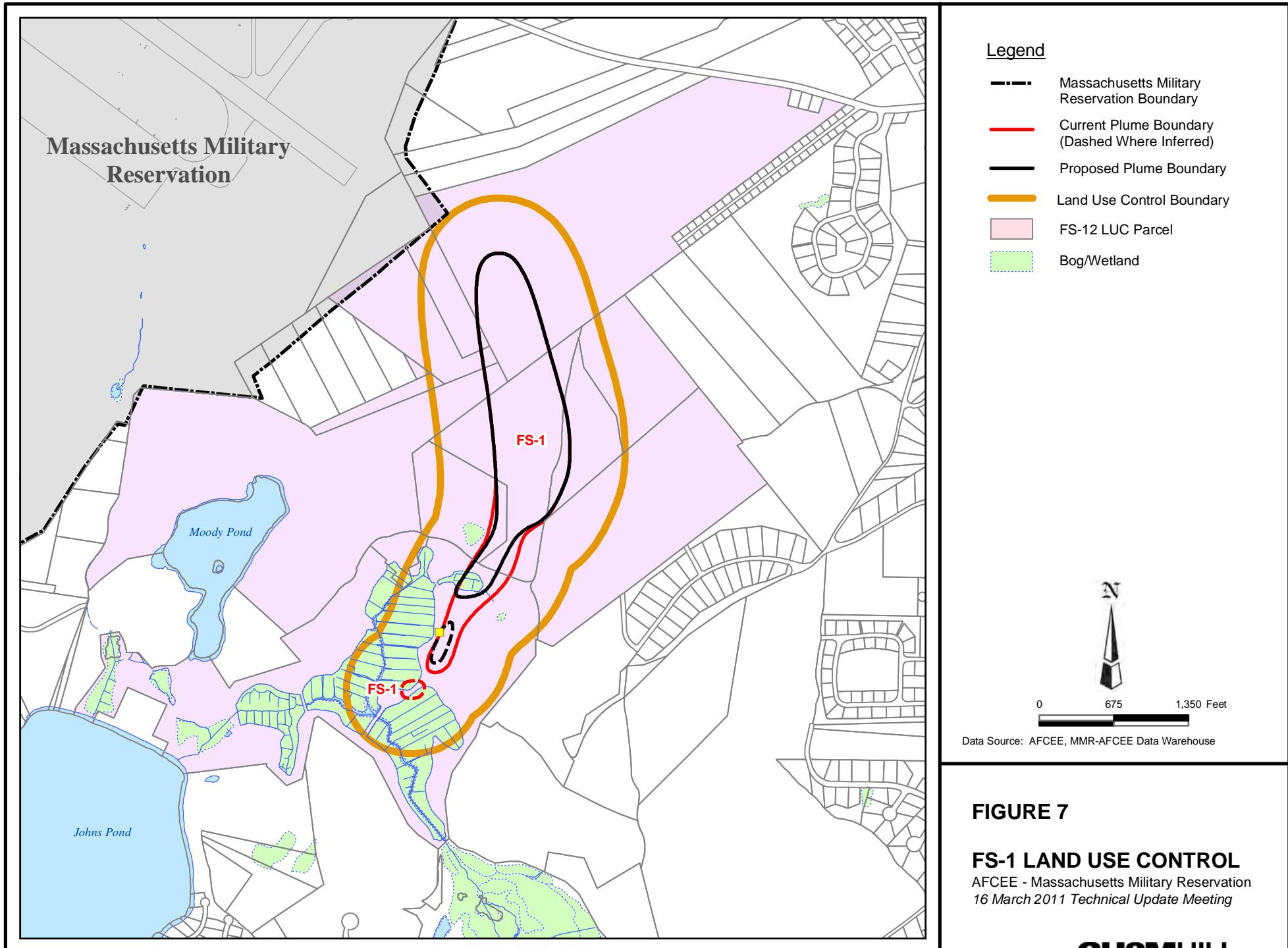
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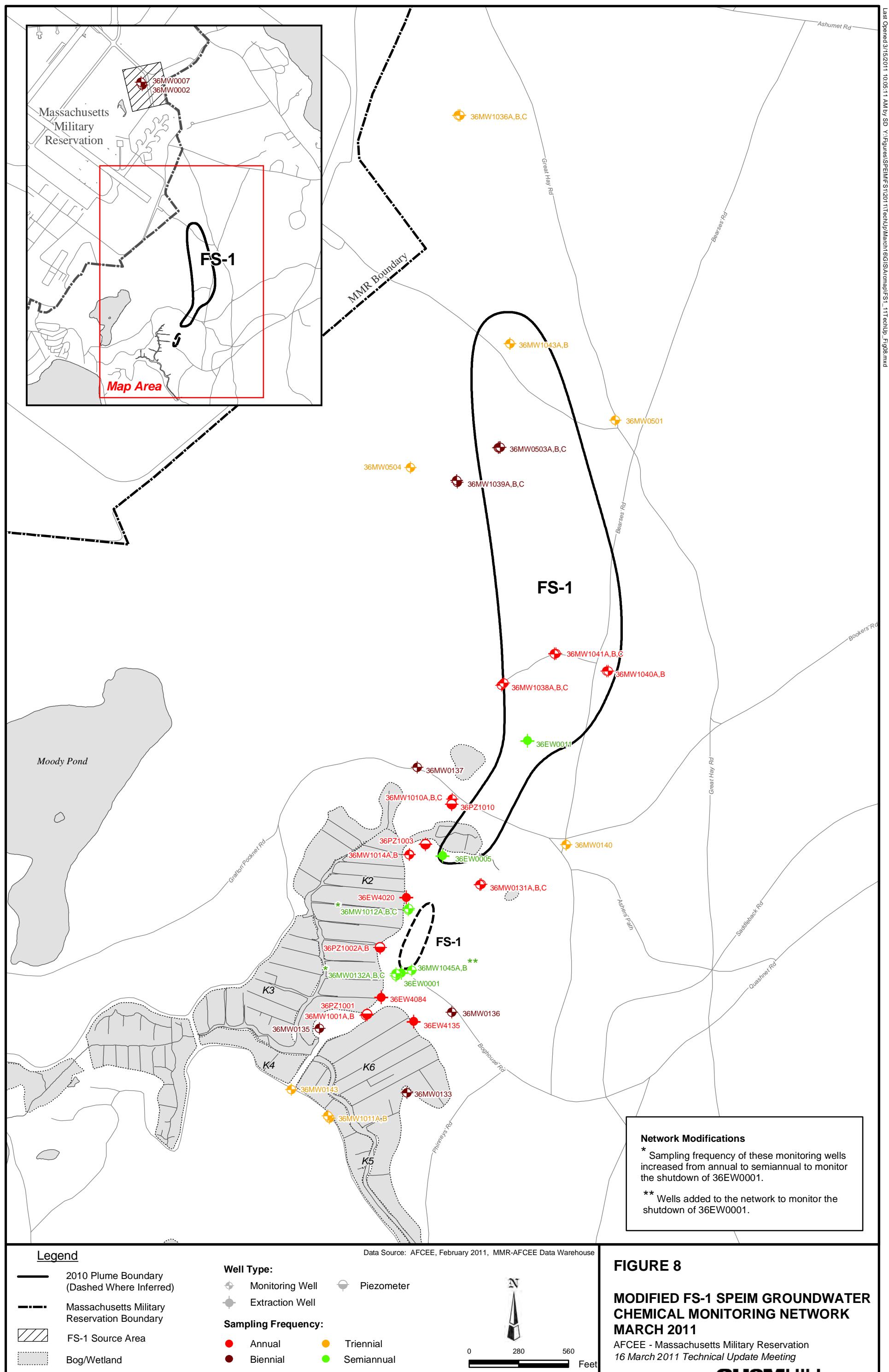
FIGURE 5

FS-1 CROSS-SECTION B-B'

AFCEE - Massachusetts Military Reservation
16 March 2011 Technical Update Meeting







ATTACHMENT B

HILYARD, MARK D CTR USAF ACC AFCEE/EXEE

Subject: FW: Reducing Surface Water Sampling at Quashnet Area - Proposal_DC

-----Original Message-----

From: Andrew McManus <mailto:amcmanus@mashpeema.gov>
Sent: Monday, August 22, 2011 8:39 AM
To: MINIOR, MICHAEL E GS-13 USAF AETC EXE
Subject: RE: Reducing Surface Water Sampling at Quashnet Area - Proposal

Mike,

Yes, the commissioners support the proposed changes to the surface water sampling plan...

-Drew

-----Original Message-----

From: MINIOR, MICHAEL E GS-13 USAF AETC EXE <mailto:michael.minior@us.af.mil>
Sent: Wednesday, August 17, 2011 9:46 AM
To: Andrew McManus
Subject: FW: Reducing Surface Water Sampling at Quashnet Area - Proposal

Drew.... back in mid July, you were going to check with the Commissioners about our proposal to reduce the surface water monitoring. Did they support our proposed changes? We would like to finalize our sampling plan for the coming year and would appreciate the commission's input.

Mike
// SIGNED //
Mike Minior
HQ AFCEE/EXEE/MMR
DSN 557-4672 Comm 508-968-4672

-----Original Message-----

From: Andrew McManus <mailto:amcmanus@mashpeema.gov>
Sent: Wednesday, July 13, 2011 12:38 PM
To: DAVIS, JONATHAN S GS-14 USAF AETC EXE
Subject: RE: Reducing Surface Water Sampling at Quashnet Area - Proposal

Hello Jon,

I have forwarded your e-mail on to our commissioners and I will await their feedback prior to concurring with the changes in surface water monitoring. As you are aware, the commission has decided to forego any plans for cranberry production at the Quashnet Bogs; however, we are currently working towards Quashnet river/habitat restoration and thus I would like to get the commission's feedback on this report before I send official concurrence.

I would be very interested to attend any future meetings in regards to operational updates to the FS-1 treatment operation, so please let me know about future meeting dates, times, etc. I remember when I came on board as the assistant agent, the meetings were held here at Town

Hall; however, I never received notification of the last meeting date (and possibly prior meeting dates)

Thanks

-Drew McManus
Mashpee Conservation
508-539-1400 X8539
amcmanus@mashpeema.gov

-----Original Message-----

From: DAVIS, JONATHAN S GS-14 USAF AETC EXE [\[mailto:jonathan.davis.2@us.af.mil\]](mailto:jonathan.davis.2@us.af.mil)
Sent: Wednesday, July 13, 2011 12:02 PM
To: Andrew McManus
Cc: MINIOR, MICHAEL E GS-13 USAF AETC EXE; FORBES, ROSE H GS-13 USAF AETC EXE
Subject: Reducing Surface Water Sampling at Quashnet Area - Proposal

Hello Drew-

We are proposing to monitor surface water at Quashnet River at one location, once per year, to track what remains of the plume near K-6 (as outlined in attached project note).

Before MassDEP concurs, they are requesting concurrence from the Mashpee Cons Comm that no cranberry farming is planned and that change in surface water monitoring is accepted (since this change is rooted in the fact that cranberry farming has been curtailed and is not planned in the future).

Can you review and let me know if you concur or have follow-on questions, etc?

Thanks

Jon

//SIGNED//
Jonathan S. Davis, P.E., GS-14, DAF
Remediation Program Manager
DSN 557-4670, x4952, COMM 508-968-4670, x4952



CH2MHILL

PROJECT NOTE

TASK ORDER
0300PROJECT NO.
420005

AFCEE
SPEIM/LTM/O&M
Otis ANG Base, Massachusetts
AFCEE 4P08-FA8903-08-D-8769

DOCUMENT CONTROL NUMBER:
420005-SPEIM-FS1-PRJNOT-001

CDRL B008

PAGE 1 OF 4

Confirmation Of:	Date Held:
<input type="checkbox"/> Meeting	Location: Large IRP Conference Room
<input type="checkbox"/> Change Notice	Date Issued: 27 February 2012
<input checked="" type="checkbox"/> General Project Note	Recorded By: Mark Hilyard
Subject: FS-1 2011 ANNUAL SPEIM DATA PRESENTATION (JAN 2011- JUNE 2011), ETD SYSTEM OPTIMIZATION UPDATE AND SOURCE AREA GROUNDWATER MONITORING UPDATE EPA OU-06	Issued By: Nigel Tindall  CH2M HILL TECHNICAL SERVICES GROUP MANAGER

ITEM	REMARKS
1.0	<p>INTRODUCTION</p> <p>This project note summarizes the Fuel Spill-1 (FS-1) 2011 annual data presentation, which included data collected for the FS-1 System Performance and Ecological Impact Monitoring (SPEIM) program between January and August 2011. In addition, the data presentation included an update to the ongoing optimization evaluation of the FS-1 extraction, treatment, and discharge (ETD) system. The data presented includes results from the following sampling events:</p> <ul style="list-style-type: none">• Annual sampling of 33 monitoring wells (June-11)• Annual sampling of 3 extraction wells (June-11)• Monthly treatment plant sampling (Jan-11 through Jun-11)• Annual water sampling at Quashnet Bog (Aug-11)• Optimization-related flow testing results at 36EW0001 (Jul-11 through Oct-11) <p>These data were presented to the regulatory agencies during the 17 November 2011 Technical Update meeting.</p> <p>This project note also documents the FS-1 2011 Source Area Groundwater Monitoring Update which was presented to the regulatory agencies during the 26 January 2012 Technical Update meeting and provided the results of biennial sampling for lead at two source area monitoring wells completed in June 2011. The 17 November 2011 data presentation is included as Attachment A and the 26 January 2012 Source Area Groundwater Update is provided as Attachment B.</p>

 CH2MHILL AFCEE SPEIM/LTM/O&M Otis ANG Base, Massachusetts AFCEE 4P08-FA8903-08-D-8769	PROJECT NOTE	TASK ORDER 0300
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ITEM	REMARKS
2.0	<p>BACKGROUND</p> <p>The FS-1 plume is detached from its source area and is defined as the extent of groundwater contaminated with the contaminant of concern (COC), ethylene dibromide (EDB), at concentrations exceeding the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter ($\mu\text{g}/\text{L}$). The FS-1 EDB plume is being remediated through the operation of the FS-1 ETD system, which currently extracts contaminated groundwater via three extraction wells at a combined pumping rate of 515 gallons per minute (gpm). The source area for the FS-1 groundwater plume is located on base and the selected remedy is long term monitoring. Lead, thallium and toluene are COCs for the FS-1 source area groundwater. However, the source area groundwater is no longer sampled for toluene and thallium because toluene has not been detected at concentrations above the Maximum Contaminant Level of 1,000 $\mu\text{g}/\text{L}$ since 1999 and thallium was not detected at source area groundwater monitoring wells during twelve sampling event completed between 2002 and 2005. The FS-1 source area groundwater is currently monitored for lead at two groundwater monitoring wells that are sampled on a biennial frequency.</p> <p>Analytical data for the FS-1 plume have been collected through the SPEIM program since startup of the ETD system in 1999. This program was developed to monitor plume changes and to ensure the effective operation of the AFCEE groundwater remediation systems at the Massachusetts Military Reservation; monitoring networks are also evaluated and optimized through the SPEIM program. The current approved FS-1 SPEIM monitoring network, including analytical scope and methods, is presented in the <i>Comprehensive Long Term Monitoring Plan</i>, which is available on-line at www.mmr.org under Plans and Protocols.</p>
3.0	<p>RESULTS</p> <p><u>SPEIM Monitoring</u></p> <p>Analytical results and concentration trend graphs were presented for select wells that are monitored throughout the FS-1 plume (Attachment A). Cross-sectional representations of the FS-1 plume and EDB trends in groundwater and surface water were updated using the most recent data. An overview of the ETD system performance for the reporting period was also presented by providing treatment plant influent concentration trends, EDB mass removal, volume of groundwater treated, frequency of carbon exchanges, extraction well operational rates, and air emissions associated with the operation of the system.</p> <p>The data collected through the SPEIM program indicate that the remedial goals for the FS-1 ETD system are being met and that plume cleanup is progressing as predicted. North of 36EW0011 shallower portions of the aquifer have cleaned up and the remaining EDB plume is observed at wells screened deeper in the aquifer. South of 36EW0011, concentrations of EDB have decreased significantly at all well screen depths since system startup (Figure 3, Attachment A). Concentrations of EDB reported at surface water monitoring location 36SW0019 are generally decreasing and are expected to continue to decrease with time (Figure 7, Attachment A).</p>

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ITEM	REMARKS
	<p>Plant influent monitoring data indicate that the northernmost extraction well, 36EW0011 is capturing the most mass and that, due to a significant reduction in plume footprint and EDB concentrations south of 36EW0011, the mass removal efficiency of 36EW0005 and particularly 36EW0001 has decreased with time (Figures 8 and 9, Attachment A). Therefore, the ongoing optimization evaluation of 36EW0001 should continue.</p> <p><u>Flow Testing at 36EW0001</u></p> <p>The results of flow testing at 36EW0001 were also presented at the 17 November 2011 Technical Update meeting (Attachment A). Flow testing results collected to date indicate that reducing the screen length with packers did not result in an increase of EDB concentrations while the well was operating at the design rate of 90 gpm (EDB influent concentrations remained below the MMCL of 0.02 µg/L). However, sampling of this extraction well immediately upon startup after a one week rest period (after a minimum purge was achieved) resulted in an EDB influent concentration of 0.021 µg/L, which was slightly above the MMCL. These flow testing results indicated that a relatively small area of EDB plume may be present in the immediate vicinity of the well screen. Therefore, flow at this well was reduced to an interim flow rate of 45 gpm and influent sampling would continue. The optimization evaluation of 36EW0001 will continue and any recommended optimizations will be summarized in a separate, follow-on project note.</p> <p><u>Source Area Monitoring</u></p> <p>The results of long term monitoring for lead at the FS-1 source area monitoring wells were presented at the 26 January 2012 Technical Update meeting (Attachment B). The results of the biennial sampling event at the source area indicate that concentrations of total lead in source area are at or below the clean up standard of 15 µg/L, which is a treatment technique action level for drinking water in distribution systems. Concentrations of lead in source area groundwater are expected to continue to decrease.</p>
4.0	<h2>CONCLUSIONS/RECOMMENDATIONS</h2> <p><u>2011 Annual SPEIM Data Presentation</u> (17 November 2011 Technical Update Meeting)</p> <ul style="list-style-type: none"> • SPEIM groundwater monitoring data collected in 2011 continue to support the current FS-1 conceptual site model <ul style="list-style-type: none"> – Most of the EDB plume and highest EDB concentrations (0.023 to 0.212 µg/L) are located to the north of 36EW0011 – The plume extent and EDB concentrations near 36EW0005 and 36EW0001 have decreased significantly since system startup – The concentrations of EDB in surface water at 36EW0019 are decreasing and are expected to continue to decrease with time.

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ITEM	REMARKS
	<ul style="list-style-type: none"> • No changes to the FS-1 plume or Land Use Control boundaries are warranted at this time. • Flow testing at 36EW0001 will continue and results will be reported at future Technical Update meetings. • The SPEIM chemical monitoring network should be optimized once optimization of 36EW0001 is finalized. <p><u>2011 Source Area Groundwater Monitoring Update</u> (26 January 2012 Technical Update Meeting)</p> <ul style="list-style-type: none"> • Concentrations of total lead at the FS-1 source area are either at or below the cleanup standard of 15 µg/L for lead. • Sampling for lead at the source area will continue to monitor trends at the source area. • No changes to FS-1 source area monitoring network at this time.
5.0	<p>REGULATOR COMMENTS/ACTION ITEMS</p> <p>No comments were received on the FS-1 2011 Annual SPEIM Data Presentation from the regulatory agencies at the 17 November Technical Update meeting.</p> <p>A check-in with regulatory agencies was conducted at the 26 January 2012 Technical Update meeting and no additional comments regarding the conclusions associated with the FS-1 2011 Annual SPEIM Data Presentation were received. Additionally, the regulatory agencies had no comments regarding the results or conclusions associated with the 2011 Source Area Groundwater Monitoring Results and agreed that the project note documenting these two data presentations could be submitted. The results of the on-going optimization of 36EW0001 will be documented in a future project note.</p>

Attachments:

- Attachment A: FS-1 2011 Annual SPEIM Data Presentation and ETD System Optimization Update, 17 November 2011 Technical Update Meeting
- Attachment B: FS-1 2011 Source Area Groundwater Monitoring Update, 26 January 2012 Technical Update Meeting

ATTACHMENT A

FS-1 2011 Annual SPEIM Data Presentation and ETD System Optimization Update

17 November 2011 Technical Update Meeting

Presentation Overview

Groundwater Sampling Results (Figures 1-6):

- Annual sampling of 33 monitoring wells (June -11)
- Annual sampling of 3 extraction wells (June-11)

Surface Water Sampling Results (Figure 7)

- Annual Sampling at Quashnet Bog (Aug-11)

ETD System Performance Monitoring (Figures 8 and 9)

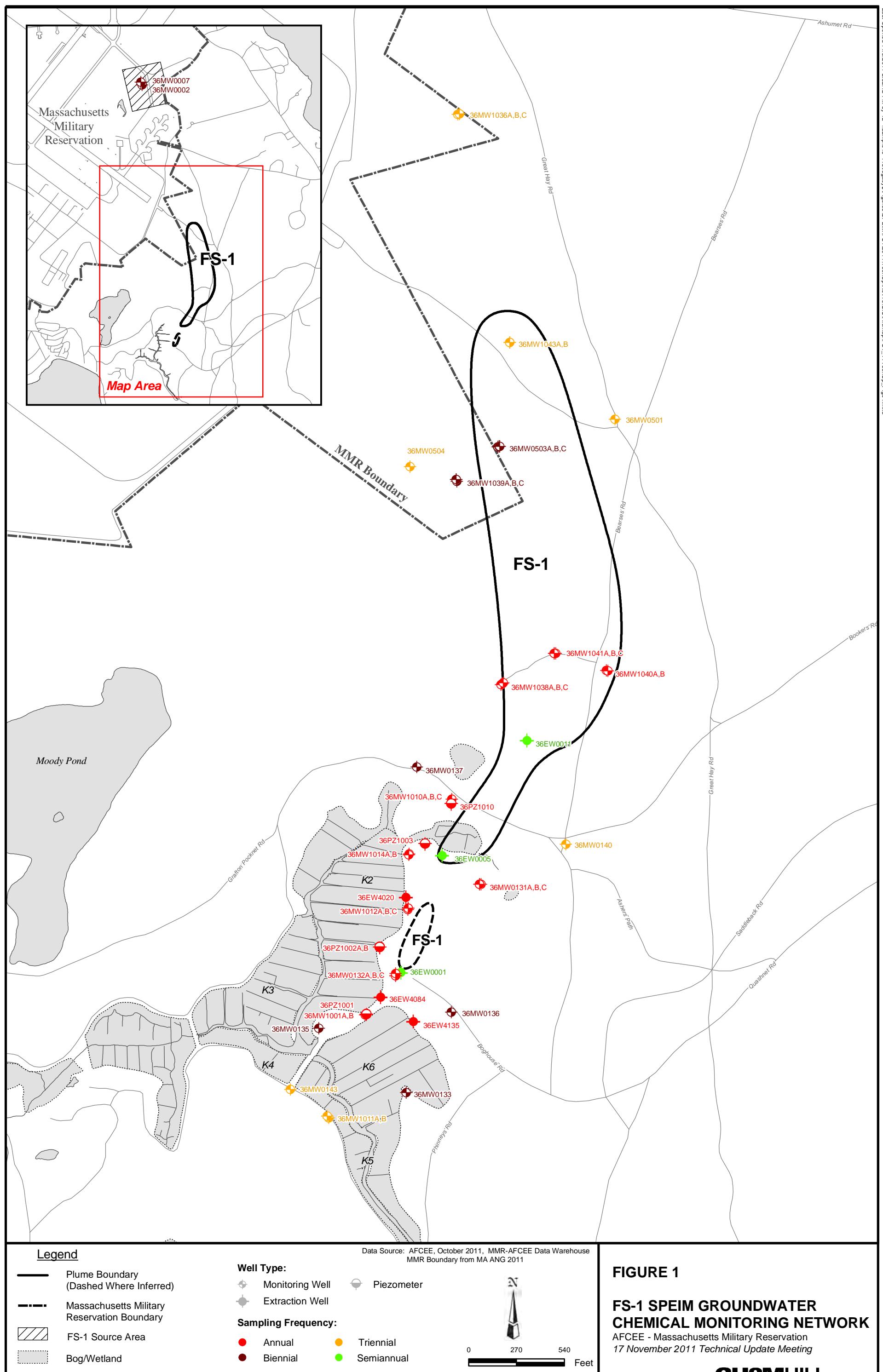
- Treatment plant influent (Jan-11 through June-11)

SPEIM Conclusions (Figure 10)

ETD System Optimization Update

- Post-packer influent sampling at 36EW0001 (Jul-11 through Oct-11)

Recommendations



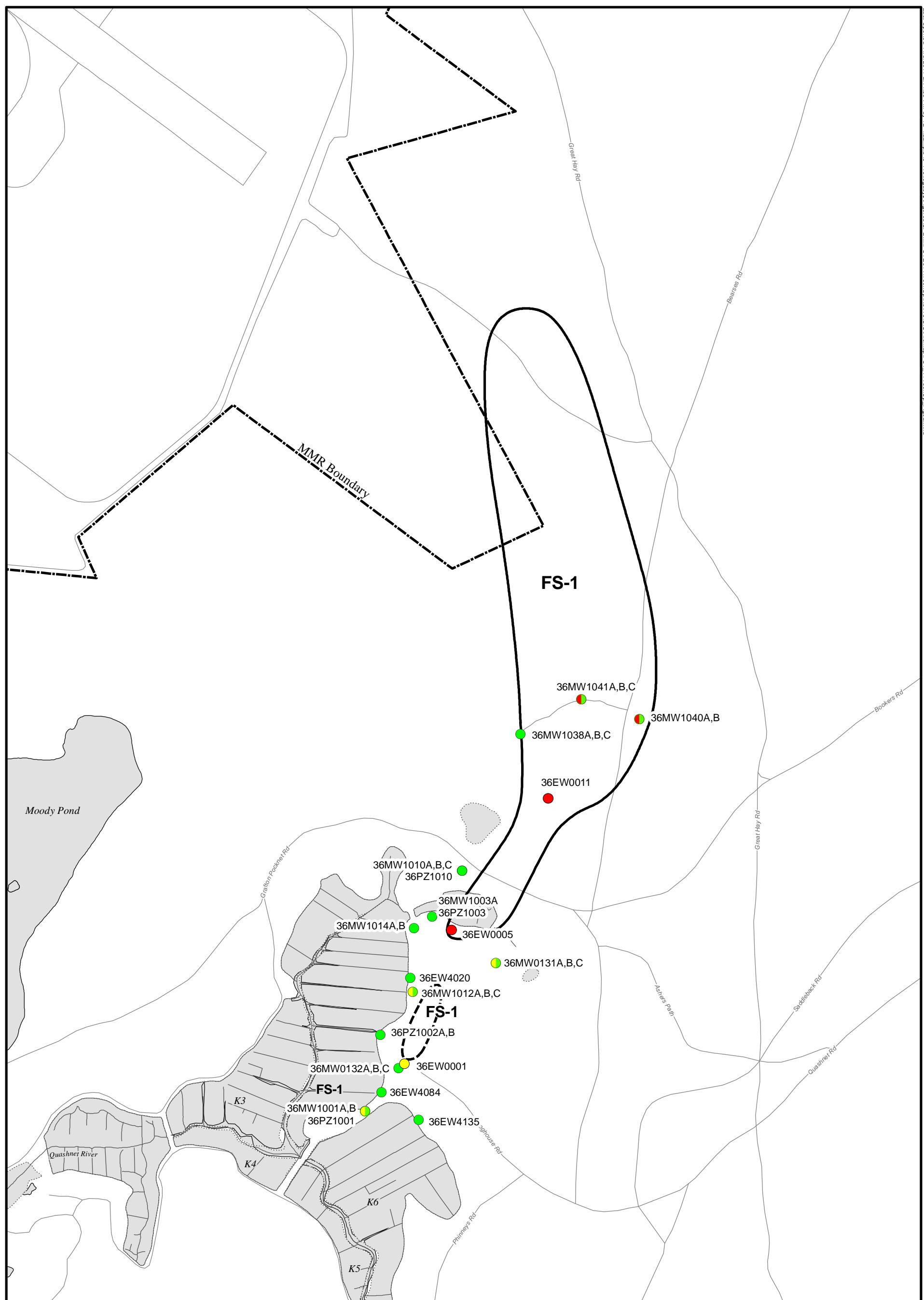
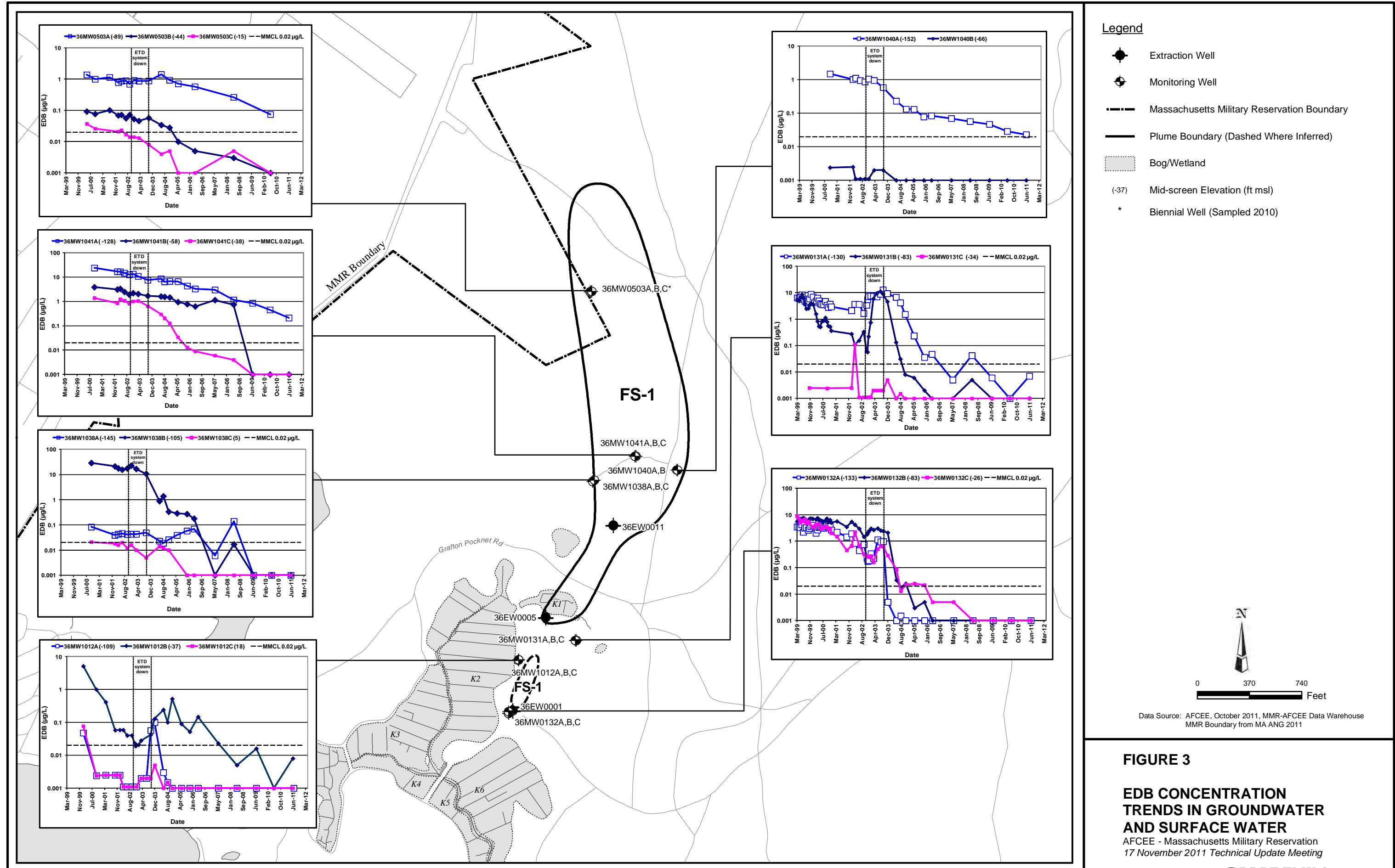


FIGURE 2
FS-1 2011 ETHYLENE DIBROMIDE DETECTIONS
AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting

FS-1 2011 Annual SPEIM Data Presentation

Groundwater Highlights

- EDB Concentrations south of Grafton Pocknet Road
 - No detects of EDB at most groundwater monitoring locations, south of Grafton Pocknet Road.
 - Timeframe when EDB concentrations reached sub-MMCL concentrations at all screens at each location:
 - 36PZ1002 (1998*) * No historic EDB detections
 - 36MW1014 (2005*)
 - 36MW1010 (2005)
 - 36EW4020 (2007)
 - 36MW0131 (2007)
 - 36MW1003 (2008)
 - 36MW1012 (2008)
 - 36EW4084 (2009)
 - 36MW1001 (2009)



FS-1 2011 Annual SPEIM Data Presentation

Groundwater Highlights (cont.)

- EDB concentrations north of Grafton Pocknet Road (36EW0011)
 - 36MW1038 cluster remain ND
 - 36MW1040A at 0.023 µg/L in Jun-11 (similar to June-10)
 - 36MW1040B - remains ND
 - 36MW1041 cluster ND or decreasing:
 - “A” screen 0.212 µg/L (down from 0.857 µg/L in June-09 and 0.454 in June-10).
 - “B” and “C” screens remain ND

FS-1 2011 Annual SPEIM Data Presentation

Groundwater Highlights (cont)

- Trend analysis at well clusters indicates that plume cleanup is progressing as predicted
- North of 36EW0011, shallower portions of the aquifer have cleaned up and the remaining EDB plume is observed primarily at wells screened deeper in the aquifer.
- South of 36EW0011, the plume footprint has decreased significantly near 36EW0005 and 36EW0001.



FIGURE 4

FS-1 EDB PLUME AND LOCATION OF CROSS-SECTION LINES
AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting

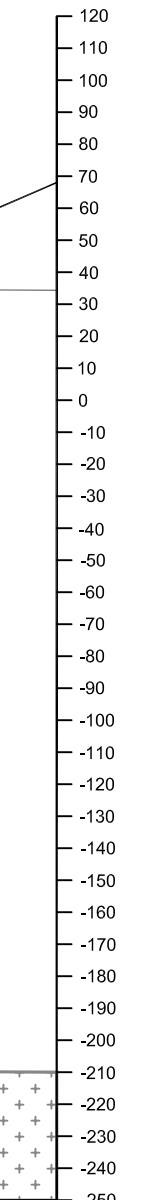
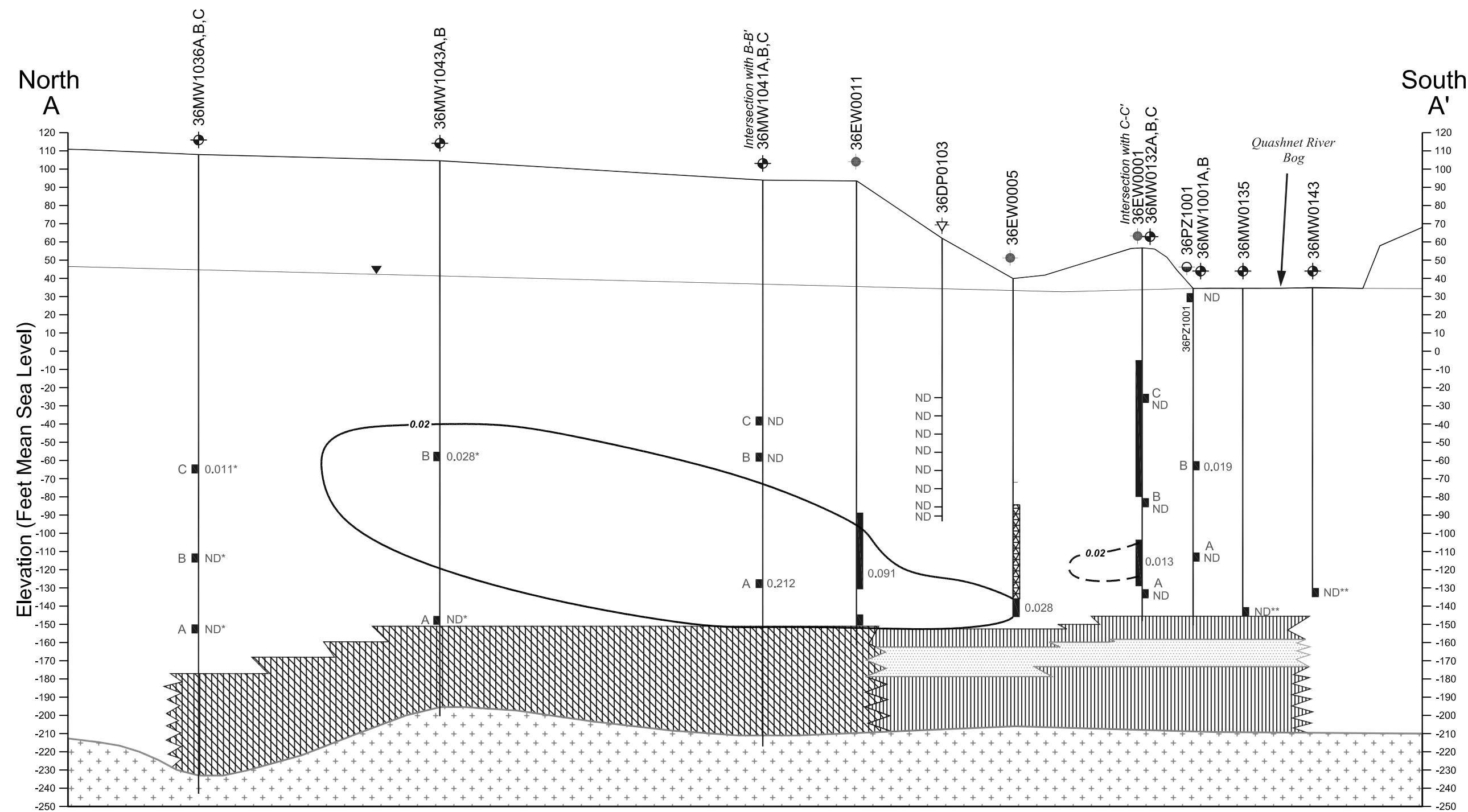
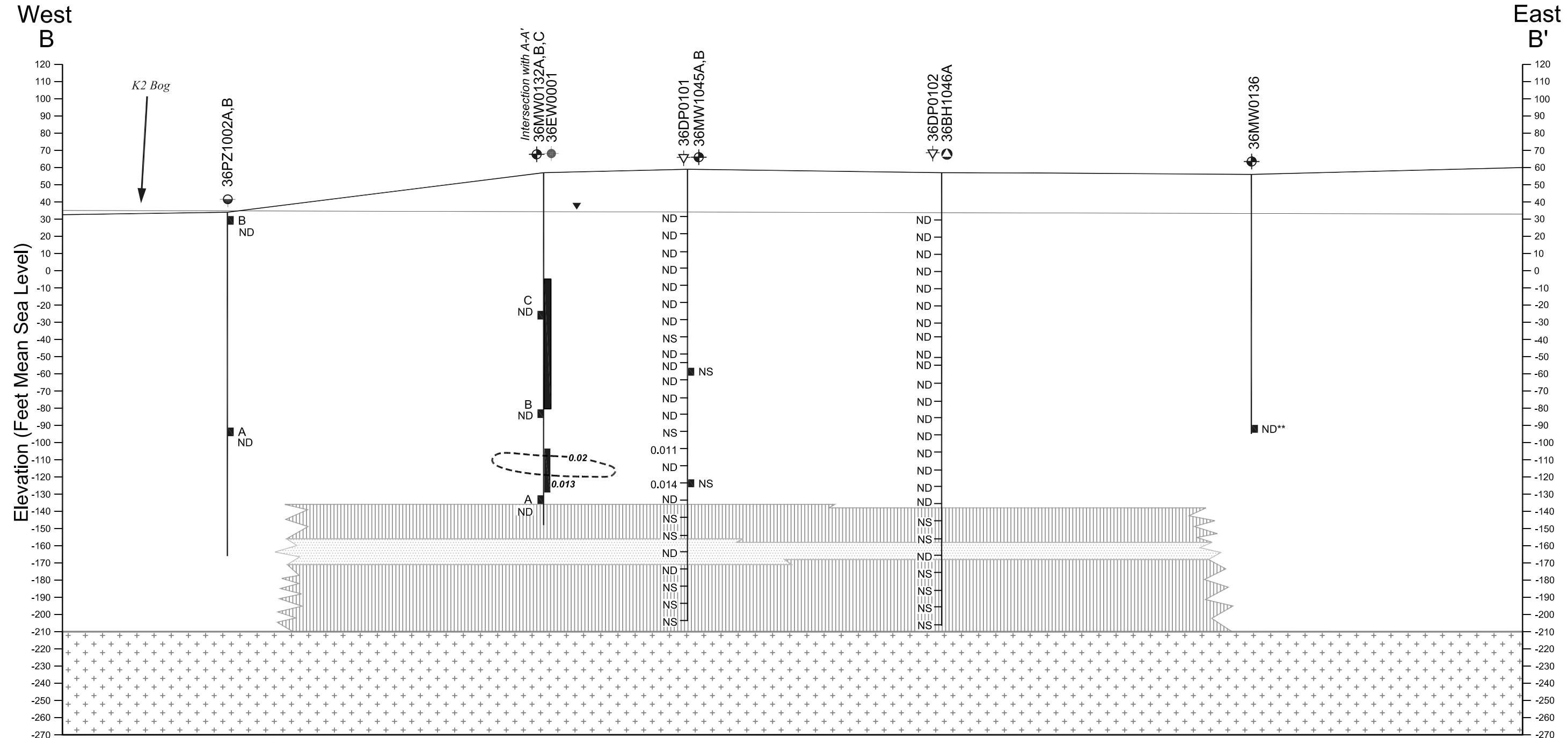


FIGURE 5

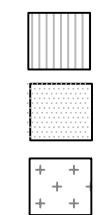
FS-1 CROSS-SECTION A-A'
AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting



Legend

- Monitoring Well
- Piezometer
- Extraction Well
- Direct Push
- Water Table
- Sonic Boring
- EDB Isoconcentration Contour (Dashed Where Inferred)
- Vertical Profile Results (2010)

- Well Screen
- 0.011 Most Recent EDB Result from June 2011, unless otherwise noted (µg/L)
- ND Nondetect
- NS Not Sampled



** Biennial Well Latest Available Data
06/11/2011

Data Source: October 2011, AFCEE, MMR-AFCEE Data Warehouse

V: 60
H: 60
Feet

FIGURE 6

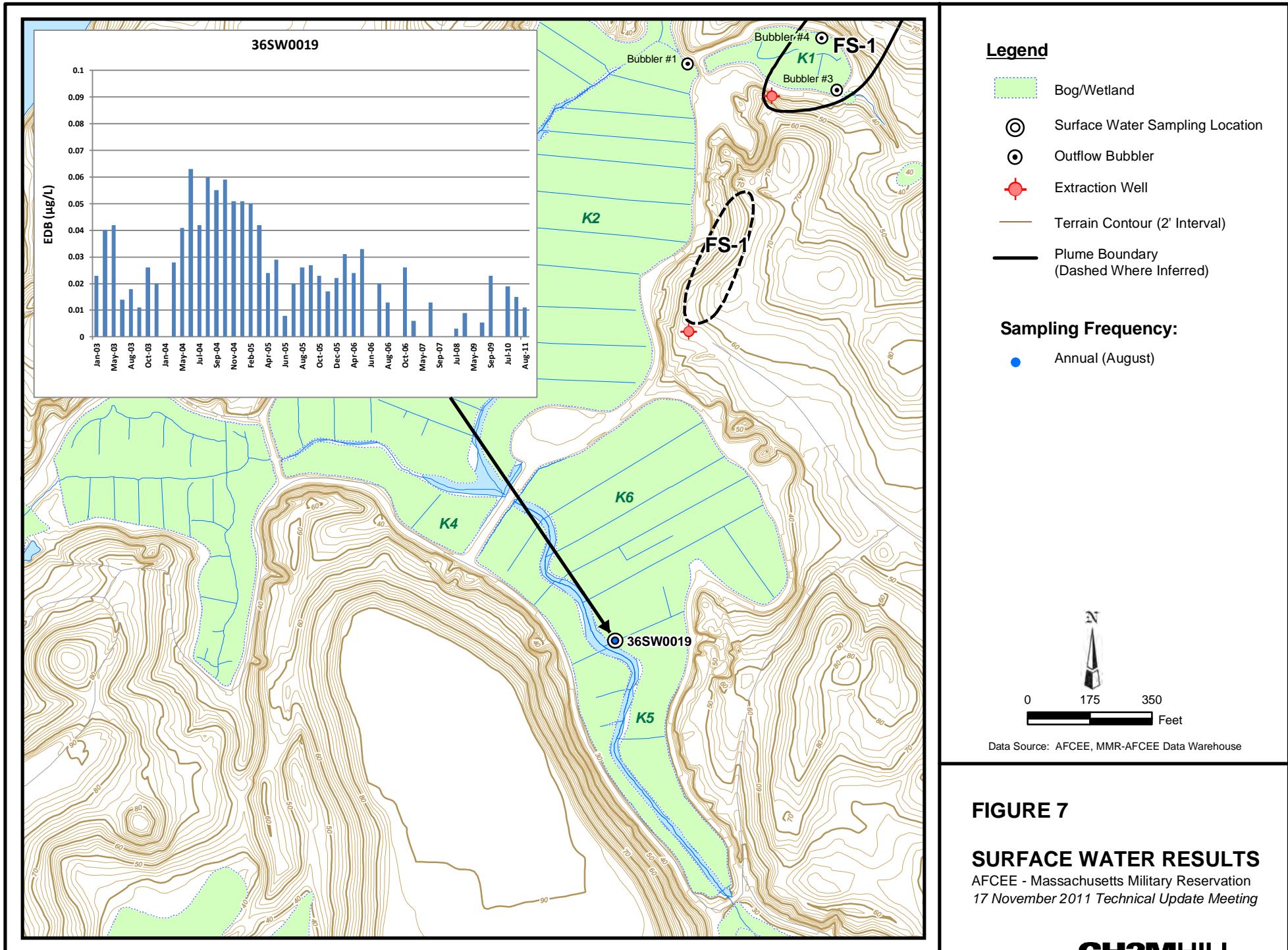
FS-1 CROSS-SECTION B-B'

AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting

FS-1 2011 Annual SPEIM Data Presentation

Surface Water Results

- Surface water monitoring network optimized in 2011 – reduced to one location (36SW0019) and is intended to monitor discharge to surface water of residual EDB that is beneath the bogs
- Aug 2011 - EDB was reported at 0.011 µg/L at 36SW0019
- EDB concentrations at this location have been decreasing and are expected to continue to decrease over time.



FS-1 2011 Annual SPEIM Data Presentation

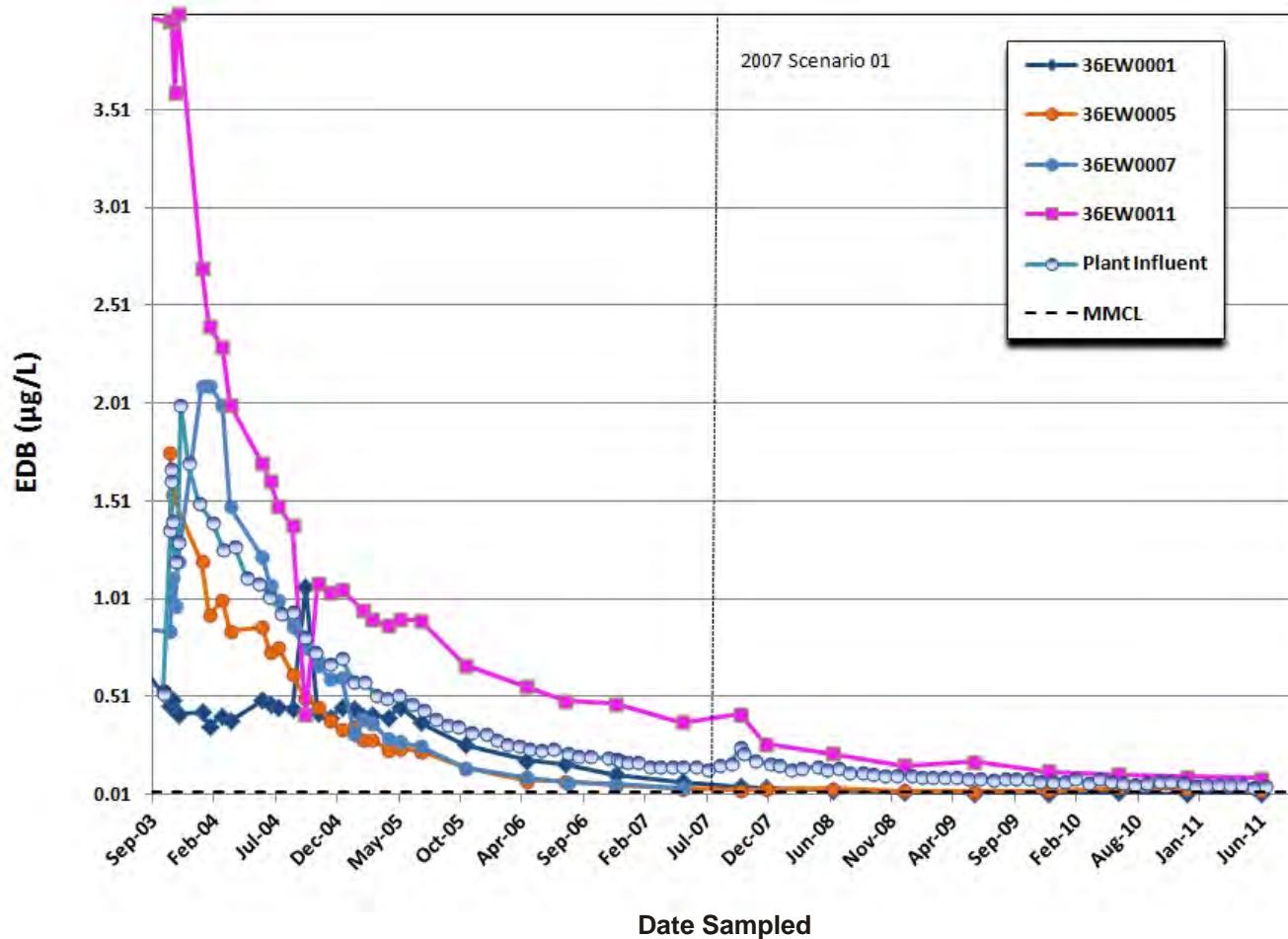
ETD System Performance Monitoring (Jan-11 through Jun-11)

- ETD system operated with 2007 Scenario 01 pumping configuration
 - 90EW0001 – 90 gpm
 - 90EW0005 – 175 gpm
 - 90EW0011 – 250 gpm
 - Combined Flow rate: 515 gpm
- Extraction wells operated between 95%-99% of design rates
- Approximately 133 million gallons of groundwater treated by ETD system
- 0.06 pounds of EDB removed (17.82 pounds since system startup)
- 1 carbon exchange

FS-1 2011 Annual SPEIM Data Presentation

ETD System Performance Monitoring (Jan-11 through Jun-11)

- Extraction well and plant influent concentration trends (Figures 8 and 9)
 - Influuent concentrations have decreased significantly since 2003 as remediation of the plume has progressed.
 - 36EW0011 currently capturing the most mass at FS-1 ETD system
 - 36EW0005 influent concentrations slightly greater than the MMCL
 - Expected to continue decrease as the volume of the plume near this well decreases
 - Influuent concentration at 36EW0001 have been sub-MMCL since 2008
 - Optimization evaluation is in progress.

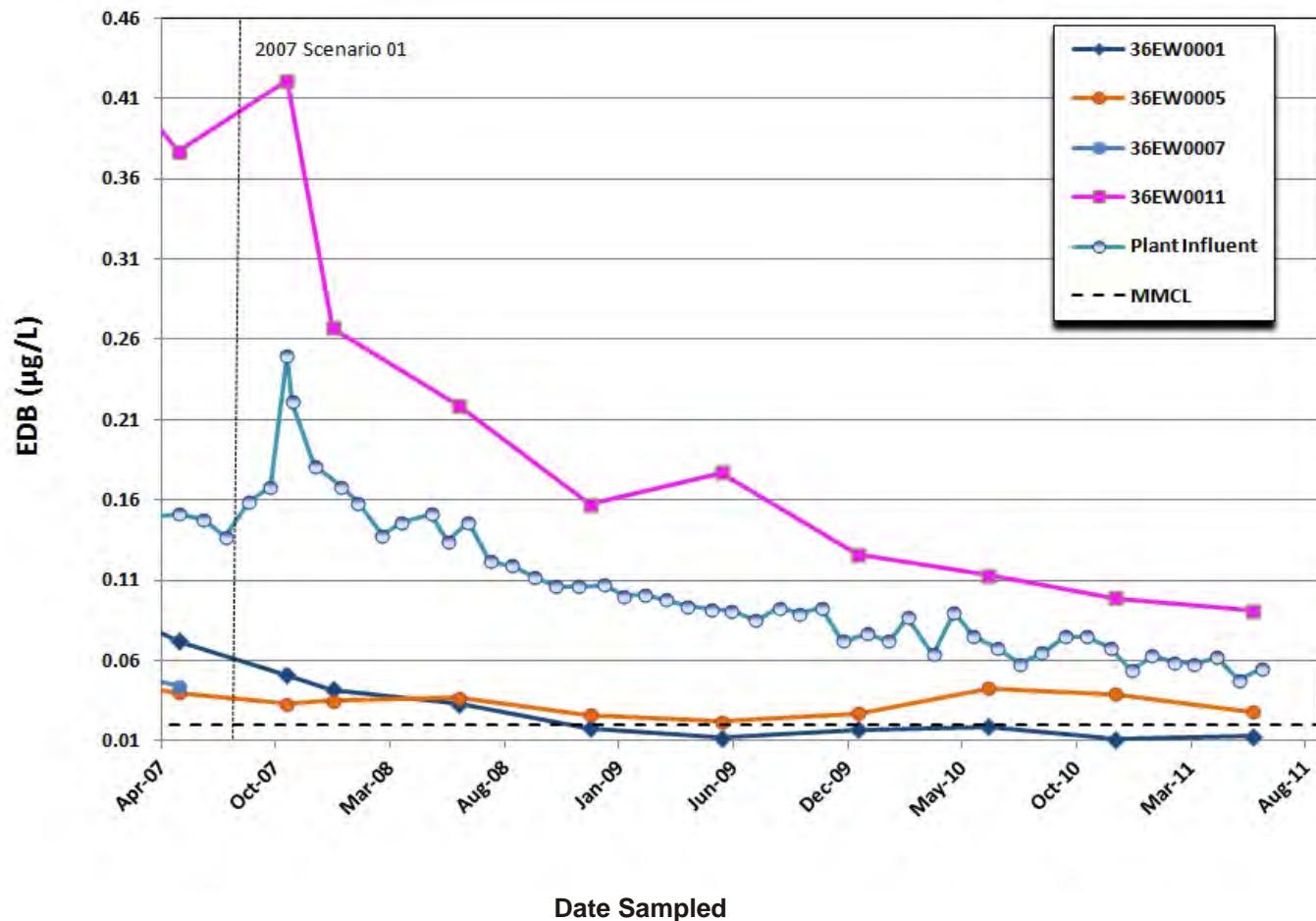


Data Source: AFCEE, September 2011, MMR-AFCEE Data Warehouse

FIGURE 8

FS-1 EXTRACTION WELL AND PLANT INFLUENT DATA (2003 - PRESENT)

AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting



Legend

Data Source: AFCEE, September 2011, MMR-AFCEE Data Warehouse

FIGURE 9

FS-1 EXTRACTION WELL AND PLANT INFLUENT DATA - 5 YEAR OVERVIEW

AFCEE - Massachusetts Military Reservation
17 November 2011 Technical Update Meeting

FS-1 2011 Annual SPEIM Data Presentation

ETD System Performance Monitoring (Jan-11 through Jun-11)

- Air Emissions (Table 1)
 - EDB Mass removed by ETD system = 0.06 lbs
 - Estimated VOC mass potentially emitted assuming traditional New England power mix = 12 lbs
 - Estimated VOC mass emitted considering contributions from AFCEE wind turbine and green power purchases = 4 lbs

Table 1
FS-1 Remedial Systems Electrical Consumption and Associated Air Emissions
17 November 2011 Technical Update Meeting

Volume of Groundwater Treated (million gallons)		1/1/2011 to 06/30/2011	System Startup (4/1999) to 06/31/2011 ⁴
		133	3,509
Groundwater COC Mass Removal (pounds)		0.06	17.76
Electrical Usage (MWh)		253	4,247
Estimated Air Emissions ¹ (based on electrical usage)	CO ₂	166	2,817
	NOx	357	5,960
	PM-10	20	335
	SO ₂	951	15,456
	VOCs	12	211
Estimated Reduction in Air Emissions due to Green Power Purchases ²	CO ₂	83	313
	NOx	178	558
	PM-10	10	25
	SO ₂	474	994
	VOCs	6	23
Estimated Reduction in Air Emissions due to MMR Wind Turbine Operation ³	CO ₂	24	27
	NOx	51	58
	PM-10	2.9	3.3
	SO ₂	135	153
	VOCs	1.8	2.0
Estimated Total Air Emissions with consideration of Green Power Purchases and MMR Wind Turbine Operation	CO ₂	60	2,478
	NOx	128	5,344
	PM-10	7	307
	SO ₂	342	14,309
	VOCs	4	187

Notes:

1) The estimated air emissions presented in this table are based on the assumption that until 4/30/2009, the power used to operate the MMR remedial systems was provided by the Mirant Canal Station power plant in Sandwich, MA. This power plant primarily produced electricity generated by the combustion of fuel oil and has been off-line since 5/1/2009. Starting on 5/1/2009, air emissions are based on electricity generated by the average mix of power sources in Massachusetts. Air emissions were calculated using MMR utility data from AFCEE's Metrix 4 Utility Accounting Software (<http://www.abraxasenergy.com/metrix4.php>) and emission factors obtained from the following websites:

<http://www.csgnetwork.com/elecpowerpolcalc.html>

<http://www.metrixcentral.com/EmissionsCalculator/Emissions%20Factors%202004.pdf>

2) Emissions offset by purchases of electricity from renewable sources beginning 7/1/2008.

3) Emissions offset by operation of AFCEE-owned wind turbine beginning on 12/2/2009.

4) System was not operational between October 2002 and September 2003, system was down due to a fire that consumed the original plant.

Key:

COC = contaminant of concern

CO₂ = carbon dioxide reported in tons

FS-1 = Fuel Spill-1

MMR = Massachusetts Military Reservation

MWh = megawatt hours

NO_x = nitrogen oxides reported in pounds

PM-10 = particulate matter with a diameter of 10 micrometers or less reported in pounds

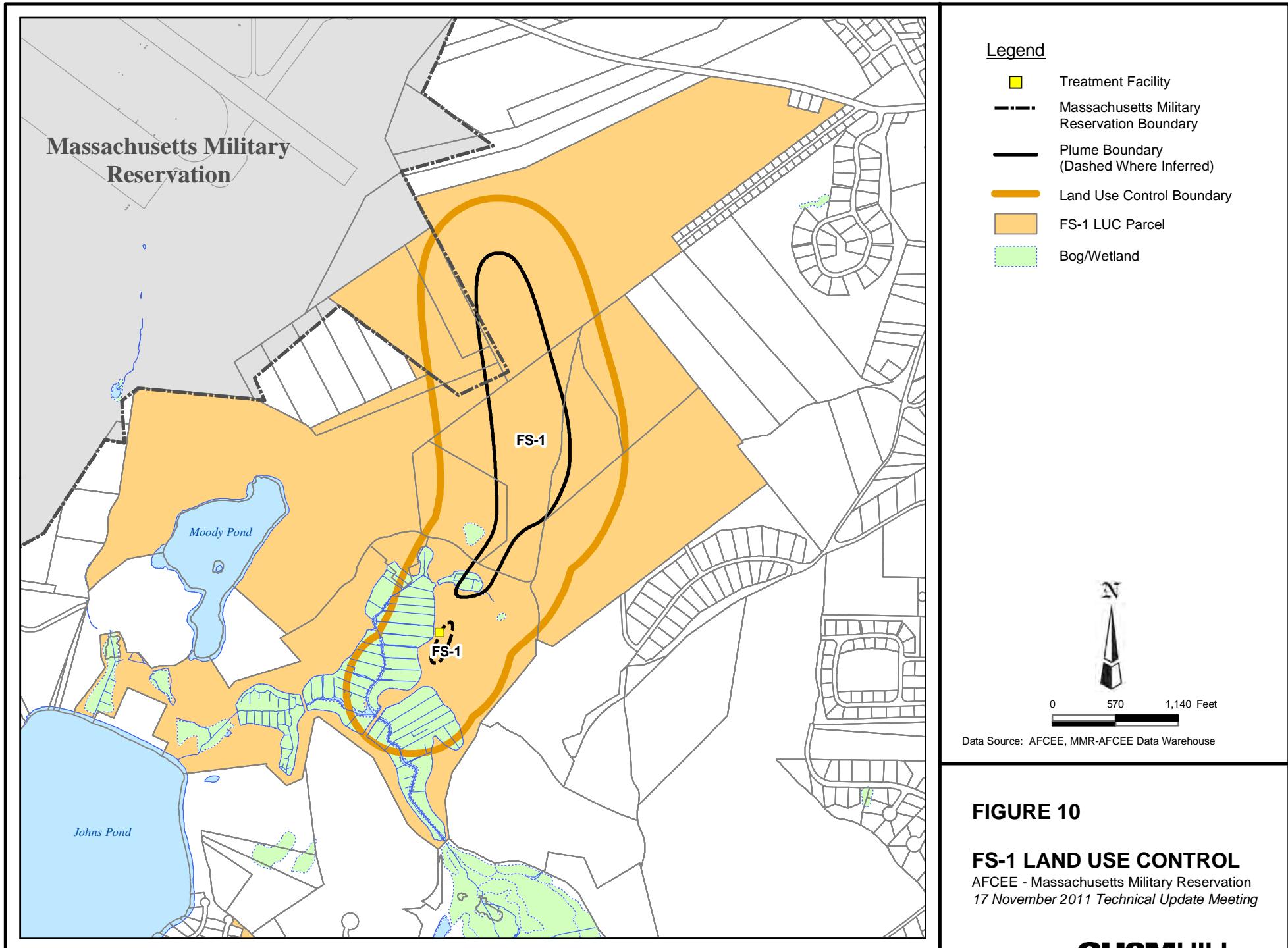
SO₂ = sulfur dioxide reported in pounds

VOCs = volatile organic compounds reported in pounds

FS-1 2011 Annual SPEIM Data Presentation

SPEIM Conclusions

- SPEIM data collected between Jan-June 2011 continue to support the current FS-1 conceptual site model
 - Most of the plume and highest EDB concentrations are located to the north of 36EW0011
 - EDB concentrations and plume extent near 36EW0005 and 36EW0001 have decreased significantly since system startup
 - SW detects at 36SW0019 are decreasing and are expected to continue to decrease
 - No changes to the plume or Land Use Control boundary warranted at this time (Figure 10).
- Mass removal efficiency of the ETD system is decreasing, primarily due to limited plume extent near 36EW0001
- Data supports prior decision to optimize 36EW0001



FS-1 ETD System Optimization Update

Post-packer Flow Testing Results

- At 16 March Technical Update meeting it was agreed that the bottom 26 feet of 36EW0001 would be isolated with packers in an effort to determine if EDB is present in the aquifer at concentrations greater than the MMCL.
- Packers were installed in July 2011. Influent sampling of the well was conducted 48 hours and 1 week after the well was restarted at 90 gpm.
- In October 2011 a minimum purge sample was collected from this 36EW0001 (extraction well was shut down for 1 week to allow the aquifer to stabilize and then sampled similar to a monitoring well).

<u>Date</u>	<u>EDB Concentrations at 36EW0001</u>
6/14/11	0.013 µg/L - re-packer installation (90 gpm)
7/22/11	0.018 µg/L - 48 hours after post-packer startup (90 gpm)
8/1/11	0.014 µg/L - 1 week after post-packer startup (90 gpm)
11/1/11	0.021 µg/L - immediately after well startup, after a minimum purge

FS-1 ETD System Optimization Update

Post-packer Flow Testing Conclusions

- Reducing the screen length of 36EW0001 with packers did not result in a significant increase in influent EDB concentrations when well operated at 90 gpm
- However, sampling of 36EW0001 immediately after a rest period indicated that EDB is present in the aquifer next to the screen at concentrations slightly above the MMCL
- Operation of 36EW0001 with packers and at a lower flow rate should improve operational efficiency of this well
- Flow has been reduced to 45 gpm and a influent sample collected (results pending)

FS-1 2011 Annual SPEIM Data Presentation and ETD System Optimization Update

Recommendations

SPEIM

- ✓ No changes to the FS-1 plume or Land Use Control boundaries (Figure 10).
- ✓ Optimize the SPEIM chemical monitoring network prior to next annual sampling event (June 2012).

ETD Optimization

- ✓ Operate 36EW0001 at interim flow rate of 45 gpm
- ✓ Complete capture zone analysis to determine flow rate needed to capture plume remnants near 36EW0001
- ✓ Once optimal flow rate is identified; operate 36EW0001 at optimized flow rate, then
- ✓ Monitor concentrations at 36EW0001 with monthly influent sampling and evaluate need to further optimize 36EW0001.

ATTACHMENT B

FS-1 2011 Source Area Groundwater Monitoring Update

26 January 2012 Technical Update Meeting

Overview

- FS-1 Source Area LTM program: Biennial sampling of 36MW0002 and 36MW0007 for total lead (Figure 1)
- Previous sampling event June 2009
- Latest event June 2011
- Lead results compared to cleanup standard for lead at FS-1 (15 µg/L), which is a treatment technique action level for drinking water in distribution systems
- Next sampling event scheduled for 2013

FS-1 2011 Source Area Groundwater Monitoring Update

Total Lead Results

- 15 µg/L at 36MW0002 (down from 30.7 µg/L in 6/09)
- 8.1 µg/L at 36MW0007 (down from 11.5 µg/L in 6/09)

